AUG 1 1 1943

The Engineer

OL. CLXXVI—No. 4567 28, ESSEX ST., STRAND, LONDON, W.C.2 JULY 23, 1943

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BSP

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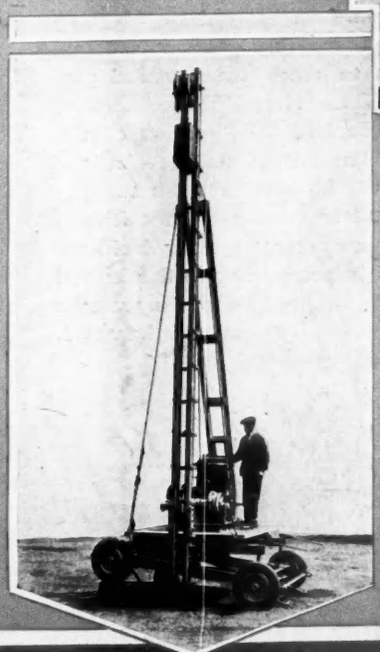

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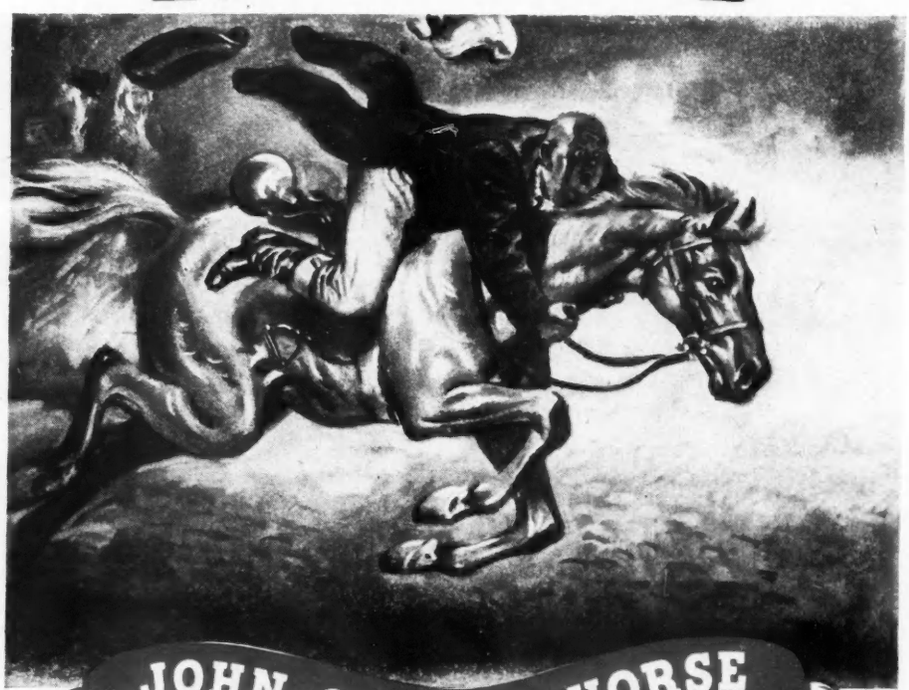

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The Engineer

LONDON, FRIDAY, JULY 23, 1943.

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The Engineer

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For continuation of Small Advertisements see page 56

A Seven-Day Journal

The Late William Robert Bousfield

ON Friday, July 16th, the death was announced of Mr. William Robert Bousfield, K.C., F.R.S., who was known to many of our older readers as an authority and leader in patent law. He died at the age of eighty-nine, at his home, "St. Swithin's," West Hill, Ottery St. Mary, South Devon. Bousfield was born at Bedford in 1854, and was the son of Edward Tenney Bousfield, an engineer. He was educated at Bedford Modern School, after which he was apprenticed to an engineer, before he gained a college scholarship, and went up to Caius College, Cambridge, in 1873. The same year he became a Whitworth Scholar and was Sixteenth Wrangler in the Mathematical Tripos of 1876. On leaving Cambridge he went to Manchester, where for some months he was in the engineering works of Sir Joseph Whitworth. He was then appointed lecturer in mathematics and engineering at Bristol. About 1880 he decided to enter legal work and was called to the Bar by the Inner Temple the same year. He became Q.C. in 1891 and was elected a Bencher of the Inner Temple in 1897. His legal work was mostly on the patent and technical sides. He was elected a Fellow of the Royal Society in 1916 as a student of physical chemistry and in recognition of his eminent technical services he was elected an Associate of the Institution of Civil Engineers. He wrote a treatise on patents and was the author of several books on the mind. These included "Neglected Complex," "The Basis of Memory," and "The Mind and its Mechanism."

Mr. L. F. G. Butler's Appointment

IT is with pleasure we record the recovery in health of Mr. L. F. G. Butler, and his appointment as technical adviser to the aero-engine division of the Bristol Aeroplane Company, Ltd. Mr. Butler has had a very long association with the motor-car engine and aero-engine industries. He served his apprenticeship with Brazil and Straker, of Bristol, where, along with Mr. A. H. R. Fedden, now Sir Roy Fedden, he took part in the design of the first Straker Squire cars. After a short time with the Rolls-Royce design staff, Mr. Butler returned to Brazil-Straker, to take up the post of chief draughtsman. The firm was then building the Rolls-Royce "Hawk" and "Falcon" engines and the 80 H.P. "Renault" engine, while it was constructing the redesigned Curtiss "OX" engine during the last war. Mr. Butler designed the "Mercury" 350 H.P. double-row engine, and at a later date he was appointed chief designer of the Cosmos Engineering Company, which in 1918 was formed to make that engine. Early in 1918 Mr. Butler designed the nine-cylinder single-row "Jupiter" engine, one or two of which were constructed by the Cosmos Company. In 1920 the company was taken over by the Bristol Aeroplane Company, Ltd., and a special aero-engine department was formed. In 1921 the Bristol "Jupiter" passed its type tests. It was followed by the "Lucifer," "Pegasus," "Mercury," "Perseus," "Taurus," and "Hercules" engines, all excellently designed, which under Mr. Butler's leadership established a high tradition for Bristol engines. Mr. Butler continued as chief designer of Bristol aero-engines until 1941, when he was appointed technical adviser to the company's aero-engine division. We are glad to hear that he has now fully recovered his health, and would express the hope that his marked ability and his long and wide experience in engine design will be available to the aircraft industry for many years to come.

The Portland Cement Industry

SPEAKING at the forty-fourth annual general meeting of Associated Portland Cement Manufacturers, Ltd., which took place in London on Thursday, July 15th, Sir P. Malcolm Stewart, the chairman of the company, referred to recent strictures which had been passed on big business, and went on to show that they were ill-founded when tested by the experience of the cement industry and his own company. Sir Malcolm said that from 1925 to 1938 the company had succeeded in reducing the cost of production per ton of annual output of Portland cement by 32 per cent. At the same time, the net selling price was reduced, per ton of cement at the works paid by the customer, by 34 per cent. That was accomplished despite the advances in the cost of fuel, steel, and stores purchased, and of increased wages and much improved conditions of work and welfare for the employees. In the main, prices during this period were controlled by the Cement Makers' Federation, but production was not controlled. The production capacity during the period was continually expanded and was kept in excess of the growing demand which was fostered by giving the customer free technical assistance and education as to the means of increasing the uses of cement through the Cement and Concrete Association. Low costs had been secured by concentration of production in the most economic units, namely, those with the lowest cost plus transport to market. That basal policy had been followed for long years. In the case of inefficient works which were economically situated, these had been completely reconstructed, but where works were uneconomically situated they were replaced by better-sited modern works. At the same time, works of potential service in times of abnormal demand had not been scrapped, but had been maintained fit for service. Sir Malcolm said that he looked for a sound measure of reasoned reform in post-war industry. He advocated the setting up of a Prices Survey Council, which would be responsible to the appropriate Minister, with the power to survey and check prices and to obtain the relevant data for that purpose. We should not under-estimate, he said, the formidable post-war tasks which would confront us.

The World's Longest Pipe Line

THE official opening ceremony of the world's largest and longest oil pipe line was performed on Monday, July 19th, at Phœnixville, Pennsylvania, by Mr. Harold Ickes, the Secretary of the Interior. The line, which runs from Longview, Texas, to the Atlantic coast of America, a distance of 1388 miles, was completed in the short time of 350 days. It has cost about £23,750,000 and is designed to deliver 12,600,000 gallons of oil per day. In an article which appeared in our issue of June 25th we described the laying of the first 531 miles from Longview, Texas, to Norris City, Illinois. The pipe line has a diameter of 24in. and each length of 40ft. weighs approximately 3784 lb. Welded joints are employed and special machines were designed for cleaning and coating the pipes with coal tar, pitch, and coal tar enamel, the completed coating being about $\frac{1}{4}$in. in thickness. In the first section of the line there are nine booster pumping stations, each of which is equipped with three single-stage centrifugal pumps, driven by 1500 H.P., 2300-volt, constant-speed, squirrel-cage motors running at a speed of 1800 r.p.m. The current is taken from suitable power stations and transmission networks, and special transformers, with the necessary switchgear for the main motors and the auxiliary plant, are provided. Having covered the first 531 miles with the nine booster stations, fifteen more stations were required for the remaining 857 miles. These stations are also equipped with centrifugal pumps driven by 1500 H.P. motors, three pumping units being used in each of the fourteen stations and three at a temporary station at Norris City. At that point the oil is delivered into 80,000-barrel tanks, which are designed to hold approximately four days' supply. From these tanks the oil is pumped into the eastern section of the line by three suction pumps, which are coupled to 100 H.P., 2300-volt, squirrel-cage motors through a fire wall. The pipe line referred to was planned by Mr. Ickes before the United States entered the war. After the Japanese attack upon Pearl Harbour its construction was seen to be absolutely necessary, and plans were formulated for the laying down of a line to carry crude oils and fuel oils, and later for a second line for the transmission of petroleum products.

The British Standards Institution

THE annual general meeting of the British Standards Institution was held at the Connaught Rooms, London, on Tuesday, July 20th, and was presided over by Sir Percy Ashley, Chairman of the General Council. In a statement on the work of the Institution, Sir Percy said that during the past year the number of contributing members had increased to 2800, and that the close collaboration with the Government Departments had continued and, indeed, advanced. With regard to the issue of specifications, a new system had been adopted in the collecting into one handy volume a number of related specifications. The first example of this system was the "Handbook of Workshop Practice," which brings together forty British Standard Specifications. The Executive Committee had now authorised the preparation of similar volumes. There was every hope of good results from the publication of the Spanish "Handbook of British Industrial Practice," which was now being distributed. The British Council had given substantial aid to the production of that publication, and also to the publication in Turkish of three engineering handbooks, based on British practice, which were now in preparation. Dealing with "Codes of Practice," Sir Percy said that the Committee which the Minister of Works decided to appoint had been constituted under the chairmanship of Sir Clement Hindley and had published a first report, which reviewed the position as to codes of practice for building. It had defined the objectives to be aimed at in the preparation of codes and had outlined a comprehensive scheme designed to ensure that the various codes shall be co-ordinated with each other and shall cover every operation involved in building work. . . . Prior to the meeting there was a luncheon, at which the principal guest was the President of the Board of Trade, Mr. Hugh Dalton. In replying to a welcome expressed to the guests by the Chairman, Mr. Dalton congratulated the Institution on the very definite contribution which its work had made to the industrial strength of the war effort. There was, he felt, great scope for co-operation and for the pooling of ideas, and the Board of Trade and other Government Departments were anxious that it should be continued in the period of post-war reconstruction.

The Late R. N. Appleby Miller

THE recent death of Mr. R. N. Appleby Miller, at his home in Newcastle-upon-Tyne, will be regretted by all those who find interest in the early history of the steam locomotive. Mr. Appleby Miller was not an engineer by training or profession, but was one of the members of the staff of the Newcastle Central Library, and a Fellow of the Library Association. His studies of early locomotive history were well known in this country and abroad, and will perhaps be best remembered by our readers by his article on a "Link in the History of the Locomotive," which we published in our issue of September 18th, 1931. In that article he brought to light a hitherto unpublished sketch of the period, found at the head of a colliery map, which represented one of George Stephenson's early experiments in steam locomotion. He made many researches on the subjects relating to the first engines of George Stephenson, Blenkinsop, Hedley, and Chapman, and many articles from his pen, illustrated by his original drawings, appeared from time to time in the technical Press. In addition to his locomotive interests, Mr. Appleby Miller wrote on other topics connected with mining engineering and with the development of mediæval firearms, many of which received wide publicity. During the last war he held commissioned rank in the Army and served abroad. His death took place at the comparatively early age of fifty-seven.

FLAME CUTTING MACHINES IN AN AMERICAN SHIPYARD

(For description see opposite page)

CUTTING END OF FLAME CUTTING MACHINE
TWO-BURNER FLAME CUTTER

TEMPLATE END OF FLAME CUTTING MACHINE
CUTTING OUT SHELL FRAMES

America's Wartime Merchant Fleet

(By an American Correspondent)

No. VIII—*(Continued from page 55, July 16th)*

ASSEMBLY AND CONSTRUCTION *(continued)*

WHILE the vessel is at the outfitting pier her standing rigging is set and the running gear for her cargo booms is installed. Also, lifeboat davits are shipped and all equipment required for lifeboats, floats, and rafts is placed aboard and in proper state for examination by the Government Inspectors. The shipyard has provided for the riggers a loft where all needful advance work on rigging can be finished preparatory to placing on shipboard. As soon as the vessel reaches the outfitting basin she is put in charge of a special trial crew that completes all unfinished work and gets the machinery ready for the preliminary trials at the pier. After that dock trial has been run the engine is checked up, metallic packing is adjusted, and everything is made ready for the official dock run. During this trial, in accordance with the requirements of the Maritime Commission, all characteristics are noted of the performance, and upon satisfactory completion of this trial the engine is lagged, the lagging having been left off until then so that any leaky joints between the cylinder, cylinder cover, &c., could be observed and corrected. A well-trained shipyard crew is available for taking each completed ship on a full day's trial run in Chesapeake Bay, and on that run all operating equipment is subjected to the tests called for by the Maritime Commission.

To go back for a moment to the concluding work on a slipway, the hull is cleaned by wire brushing off all scale and rust to receive its first coat of paint. Then, when the shell of the craft is ready, a number of coats is applied to the bottom, and from that line upward to the top of the bulwarks the skin is sprayed, first with a coat of red lead and then with a coat of spray. The shell, the deck, the mast housings, gun platforms, all that can be painted before launching, &c., represent about 15 per cent. of all surfaces that are painted. The remainder is done after launching. The final 5 per cent. of painting is completed after the ship returns from her trial run.

The days following a ship's launching and her arrival at the outfitting pier are very busy ones and would be crowded but for foresight shown in dealing with that period. Just before launching the outfitting department acquaints itself in detail with the condition of the vessel, and then the staff of that department adjusts the delivery date of the vessel agreeably to the outfitting work still to be done. This gives consideration to all the trades involved in the finishing work, and to whatever may have to be done by the sub-contractors that do the joiner work, lagging of piping, and laying or placing floor covering, and to inspection trials, and delivery. This department has so to co-ordinate all the operations involved that efficient use will be made of man power and equipment and in an orderly and non-interfering manner. What this supervision and planning involves can in part be grasped when one is reminded that as many as twenty-five different departments may be at work on a vessel at one time. On each newly launched craft, when she arrives at an outfitting pier, there is erected a small store room on her weather deck, from which materials may be withdrawn as needed. This is in lieu of obtaining the necessary materials from the main warehouse, and the adopted arrangement obviates excessive demands on transportation as well as congestion in the handling of materials at the pier. Time is thus saved and the delivery of the vessel expedited.

PERSONNEL

In the entire working organisation of Bethlehem-Fairfield Shipyard there are some key departments which contribute their share to the final result by servicing other departments. These somewhat unnoticed key departments are truly essential. These may be grouped as general labour, toolmakers, burners, patternmakers, blacksmiths, watchmen, plant guards, and firemen.

Up to the end of 1942 the shipyard trained a total of approximately 17,000 men for twenty-eight crafts or callings, the system of instruction having been started near the middle of April, 1941. The course followed subscribed to the suggestions of the Maritime Commission. If the employment department, in sizing up an applicant for a position, finds him suited for training, then the new man is sent to the training department, where he is introduced and, if found acceptable, is assigned to a particular class. The training period covers twelve weeks and is open both to new employees and to all employees of helper rating who are at work in the yard. Instruction is given for one hour a day in class rooms, and comprises blue print reading, trade subjects, models, slides, and moving pictures, which are used to simplify and to make readily understandable the more difficult angles of the topics being studied. The men spend the remainder of the working day on their respective jobs, where they can put into actual practice what they have learned in the class room. From start to finish of the course emphasis is laid on the vitally important matter of safety. When learners have finished their training course they are put out, with their tools, for a short period of time on work where they can be observed and gauged as to their fitness to do a job alone. Should a learner show aptitude before the conclusion of twelve weeks, it is the practice to assign him without delay to a job on his own. The instructors are skilled mechanics in their respective trades and have been detailed to teach after taking a ten-hour course in job instruction training. There are instructors enough to train all men required in individual groups of ten to fifteen learners. The following are the qualifying courses:—Welders, burners, pipe welders, ship fitters, drillers, reamers, chippers, caulkers, tank testers, bolters, erectors, sheet metals, machine operators, riveters, heaters, holders-on, angle smiths, riggers, furnaces, strikers, rolls, shear men, tower, bridge and steam cranes, pipe fitters, checkers, electrical, job instruction training, and foremanship training.

The question of industrial relations has been ably handled by the management of the shipyard in dealing with the certified bargaining agencies of the employees. To make certain that all matters should receive immediate attention, an assistant management's representative is assigned to each ship at the shipyard and at the fabricating plant. These representatives are charged with hearing all grievances which have not been settled by the foreman, and to make sure that every employee has an opportunity to present any matter which, as he sees it, constitutes a grievance, a definite procedure has been set up. Under this arrangement, any employee has a right to discuss any matter which he may consider a grievance with his assistant foreman, and he may request his shop steward to accompany him, or he may request his shop steward to represent him.

Agreeably to the War Production Board, a Victory Production Committee was established on April 8th, 1942. That body is made up of ten members, five appointed by the Industrial Union of Marine and Shipbuilding Workers of America and five appointed by the Bethlehem-Fairfield management. The Victory Production Committee was the primary means in stimulating the shipyard organisation to the winning of the Maritime "M"—a token of work well done for the purpose of winning the war. The Committee conducts vigorous "Suggestion Week Drives," during which hundreds of suggestions

SHIPS AT OUTFITTING PIER

TWO-BURNER FLAME CUTTER

for speedy production are received in suggestion boxes throughout the shipyard and the fabricating shops. The contributor of each accepted suggestion becomes eligible for an award established by the Maritime Commission. The suggestions may be such as will save time, save material, and upbuild the understanding of the workers about the war they are helping to fight and the importance of full production in winning it. Suggestions are also sought that will tend to reduce absenteeism.

The labours of the workers toward the common end are recognised by allotting the naming of one out of every three "Liberty" ships to a workman's wife, mother, daughter, or sister. The workman so honoured is selected by drawing in a lottery, and eligibility requires six months of service and one month of perfect attendance during the month preceding the drawing.

The Victory Production Committee continually urges the workers to their utmost effort in maintaining the present high schedule of ships to be built and delivered each month. They do this by day-to-day announcements of progress in production. The imminence of bottlenecks are pointed out and the relative standing of competing yards and ships are mentioned day by day. Production score boards display the progress of the ships throughout their construction. These and other forms of appeal are employed from time to time. There is a public address system, over which important information is broadcast to the workers throughout the shipyard and the fabricating plant. During lunch periods music is broadcast and the workers are told about production goals, the threat of bottlenecks, and how they can be prevented by the workers.

The Bethlehem-Fairfield Shipyard is situated in a section of Baltimore which initially was without adequate lodging accommodation and lacked in transportation facilities because of its remoteness from the centre of the city. These drawbacks have been largely altered for the better. There is now a street car system capable of carrying to or from the plant 5000 men within a period of half an hour, and to help matters further new access roads have been constructed. Besides, a ferry system now operates between the shipyard and the eastern section of Baltimore, lying to the north on the opposite side of the port. This, in effect, brings the plant and the opposite shore closer by saving a roundabout land run of 10 miles. Government agencies have constructed permanent and temporary homes for many of the workers. Also dormitories have been erected and arrangements have been made for motor-car trailers. More than 5500 families have thus been cared for, and construction along these lines continues.

A. B. Homer is president and J. M. Willis is vice-president and general manager of Bethlehem-Fairfield Shipyard, Inc. Mr. Willis has said: "Judged by peacetime standards, we have made remarkable progress. When I say 'we' I mean each and every employee, for obviously unity of purpose in a common cause is the very core of efficient production.

"We have some 35,000 employees. The creation of such a force from scratch has been made possible by the men who plan and direct the flow of production, and by those who, from day to day, direct the work of the men, co-ordinating the total effort in the ever-greater production of ships. . . . . The work of our engineers, our superintendents, and our foremen has been outstanding. Management has been called upon to supply the planning, the ingenuity, and the training skill to develop ship production at a rate never known before. This has demanded the ability to have open minds, the gift of grasping and putting into effect new procedures."

Plan for London*

No. II—(*Continued from page 48, July 16th*)

Railways and Tubes

LONDON'S first railway came in 1836, and it was quickly followed by others, totalling ten or more, promoted by individual and competitive companies, all attempting to reach quickly the business centres, warehouses, shops, markets, and docks. Hence, there came into existence a highly complex, and in many respects unco-ordinated, railway system, with a multiplicity of sidings, goods yards, and station buildings to meet the various demands. Most of the original lines and buildings remain, despite the amalgamations which have taken place within the last twenty years. The location of the stations was influenced to only a very limited extent by the exigencies of road transport, which, as compared with conditions to-day, was negligible. The physical make-up of London presented then, as it does to-day, great difficulties in the provision of traffic arteries. The central areas straddle a wide and winding tidal river, with a steep rise on its northern bank, and on its southern bank extensive low-lying land stretching southwards to the hills. Road and rail connections between the two banks, other than tubes, present problems because of the difference in levels. This difference largely explains the viaduct approaches on the south of the river and the cross-river railway bridges. The docks, which developed principally along the lower reaches of the northern bank, have presented obstacles to the provision of bridges or tunnels across the river.

By 1900 London had railway routes at four levels:—(*a*) Viaduct level, mainly on the south bank, with elevated stations in conjunction with cross-river bridges, giving access to ground-level stations on the north bank; (*b*) ground level, for the majority of northern and north-western termini and approaches; (*c*) subway level; and (*d*) underground railway level beginning with the City and South London, which was later augmented by the Central, Northern, Bakerloo, and Piccadilly lines.

The many and highly varied activities of modern London necessitate an elaborate arrangement of traffic routes, and tend to heighten the original complexity. First and foremost, London is a port with extensive docks and riverside warehouses, which are closely inter-related with industry, markets, and national routes. Heavy industries, commerce, and shopping areas all need transport connections. The movement of its millions of inhabitants and of visitors in great numbers, particularly at certain seasons, produces transport problems which need a well-balanced organisation capable of precise adjustments to deal with the ebb and flow.

Investigating Body Recommended

In our opinion, there are a number of difficult features which, from the planners' point of view, merit serious attention and detailed consideration, and we suggest that a specially appointed investigating body be set up for this purpose before any detailed plan for dealing with the railways is propounded.

The following are some of the main points which we suggest should be investigated by such a body:—Inconvenience of connection between main lines and suburban lines, and reduction of congestion in the suburban lines and tubes, particularly at peak periods; use of land in or near the centre for tracks, goods and marshalling yards, sidings, and coal depots; poorly planned termini and environs; a complexity of elevated tracks which obstruct rational surface development; unsatisfactory passenger tube services to certain large areas, particularly to the south of the river; inadequate road approaches to the termini and goods yards; non-existence of any organised goods circuit with receiving and distribution centres round London; antiquated conditions arising from refuelling, smoke, and noise, owing to non-electrification; incomplete system of tube connections between north and south bank stations and between the various termini; and the need for the provision of express services from the centre to airports.

Disquieting, too, is the fact that the underground railway system has been motivated, in its outer extensions, largely by projected residential development, and not by the current local needs of the community. Other matters are the absence of direct rail contact with all but one of the existing main markets and the lack of direct railway connections between dockland and the south of the river.

It appears to us from a preliminary examination of the problems that the chief directions in which alleviation of the existing difficulties might be sought are:—

(i) Improvements in the railway system as a result of increased electrification.
(ii) Better inter-running and interchange facilities between main line, underground, and suburban services.
(iii) Removal of viaducts and the adjustment of the system on the south bank.
(iv) Better receiving and distributing centres for markets, goods, coal, and minerals.
(v) The possibility of air freight services.

Planning Objectives.—As planners, we consider that there should be a comprehensive scheme of improvement of the railway system in London, and that any such scheme should have for its objectives:—

(i) Greater speed, facility of movement, and the avoidance of traffic congestion.
(ii) The reduction of overlapping and the removal of systems that are obsolete.
(iii) The freeing of land and frontages for modern needs, thereby permitting the right use of land and coherent growth.

It is highly desirable that any such scheme should be so devised that short-term programmes of works and improvements should contribute to, and not vitiate, the ultimate fulfilment of the whole.

After examining the problem, we have suggested a railway framework conforming to the general requirements of the Plan and based largely upon suggestions for improving the existing services and routes, but including the addition of new underground facilities to take suitably equipped surface rolling stock. These suggestions, we think, would constitute an important advance in the development of London's railway transport for passengers and goods.

The requirements of this Plan might be capable of achievement by alternative methods. It is a matter for investigation as to which scheme would offer the best solution.

We have assumed that the following terminal stations north of the Thames would remain:—Victoria, Paddington, Marylebone, Euston, King's Cross, Liverpool Street. We suggest that on reconstruction Euston might include the facilities of St. Pancras; Paddington might be enlarged and the frontage brought forward, and at Liverpool Street the present site might be utilised for an underground station for suburban lines, with a new main line station accommodated on the site of the present Bishopsgate goods station, and connected by a low level loop with a new station replacing the present

* "County of London Plan," MacMillan & Co., Ltd., London.—Excerpts.

Fenchurch Street Station. Both these stations would in their new positions be adjacent to the "A" ring road.

On the north bank of the river we suggest that the riverside stations at Charing Cross, Cannon Street, and Blackfriars might be replaced by underground stations below their present sites, and the three connected on an underground system which continues from Charing Cross to Victoria Station, and thence under the river to Battersea, connecting to the south-western surface system; from Cannon Street it continues to Shadwell Junction, turning south under the river, *viâ* a duplicated tunnel, to connect up with the south-eastern surface lines at Deptford.

This north bank loop would be supplemented by a deep-level link from Charing Cross to London Bridge *viâ* Waterloo Junction. We visualise Waterloo Station remaining for a considerable time until a new station, south of the present site, would give facilities for a separate low-level connection with London Bridge, there being both low and deep level interchange stations at London Bridge and Waterloo with the low level rising to the south-east and south-west respectively to contact the surface lines.

A north-south underground connection to replace the Holborn, Blackfriars, Herne Hill route is also suggested.

The suggestions which we think might be considered by a specially appointed investigating body are accordingly as follow:—

(i) Electrification of all lines leading into London, both main and suburban, from selected points (as may be most practicable) within the Outer London region, together with the provision of suitable traction for goods transport.

(ii) When new terminals are designed the use of different levels made possible by electrification, with suburban lines taken underground and flat roofs for future air landing.

(iii) Where practicable, suburban traffic should be connected with the tube systems and express lines provided.

(iv) With a view to the avoidance of traffic congestion, the suburban traffic in existing main line terminals should be separated, where possible, from the main line traffic.

(v) With a view to the elimination of some of the overhead approach lines to stations within the "A" ring road, we consider that it might be desirable to investigate the possibility of constructing two separate deep-level tracks, both operating on the loop principle and affording interchange facilities at stations on the routes; together with an independent north-south tunnel connection between the existing surface systems, viz.:—

(*a*) *North Bank Loop.*—The provision of a new deep-level loop (8 miles) from Battersea to Deptford, *viâ* Victoria, Charing Cross, Cannon Street, and extending the Southern Railway facilities along the north bank of the Thames to augment the existing East London Joint Railway at Shadwell, and thence *viâ* an additional tunnel adjoining the existing route from Wapping to Surrey Docks and Deptford.

(*b*) *South-east, City, and West End Loop.*—a new deep-level loop (6 miles) contacting Charing Cross and Cannon Street on the north bank, also Waterloo Junction and London Bridge on the south, and thence by tunnel extension *viâ* Surrey Canal rising to connect with the existing surface systems in the south and south-east.

Note.—These two underground loops are intended to dispense with the need for the existing high-level approaches to head-on terminals at Charing Cross and Cannon Street, for the existing high-level stations at London Bridge and Waterloo Junction, and for their viaduct connections. All stations concerned would be replaced by underground "through" stations on each loop.

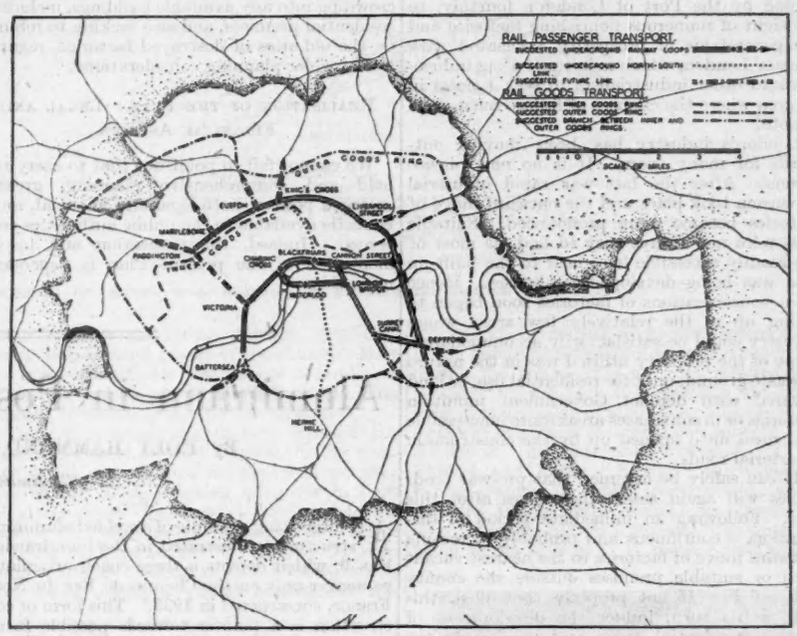
(*c*) *North-South Tunnel.*—An underground link between the northern terminals and the south-east and south-west systems. This north-south route should replace the existing viaduct from Snow Hill to Loughborough Junction, and would allow of underground "through" stations in place of Blackfriars and Elephant and Castle.

Note.—There are modifications of these suggestions which would, doubtless, be investigated. For instance, under suggestion (*a*) the investigating body might consider whether it would be worth exploring the feasibility of using the existing District Railway from Victoria to Whitechapel Junction (with suitable additional facilities) in substitution for the suggested deep-level North Bank Loop. It is understood that consideration has been given to an alternative west to east route to relieve the present heavy load over this section by a new route using normal L.P.T.B. rolling stock. If this scheme was practicable and economical, the District Line might then be taken over for operation by the Southern Railway as from sub-surface platform level at Victoria, and by the addition of certain extra low-level tracks this suggested line may achieve the same objects as the North Bank Loop. The possibility of combined road and rail tunnels on grounds of economy should be explored in cases where the lines of their routes approximately coincide.

(vi) Improvements to the northern terminals at Euston (including the possibility of combining the facilities of St. Pancras with those of Euston), King's Cross, Paddington, and Liverpool Street.

(vii) The provision of a northern arc underground suburban passenger route passing below the main line stations at Paddington, Marylebone, Euston, King's Cross, and Liverpool Street, with interchange facilities.

(viii) (*a*) The use of the northern section of the existing Metro-District Inner Circle as a goods line for distribution in the central area, especially to and from the markets, and utilising the existing connections at Bishop's Road, Paddington, and King's Cross. (*b*) The continuation of this goods ring to the south side. (*c*) An outer goods circuit or marshalling route, near the county boundary, with a cross-river tunnel at Greenwich; short links only to existing lines are needed to complete this circuit.



SUGGESTED PLAN OF LONDON'S RAILWAYS

AERODROMES

All the portents indicate that after the war there will be a very considerable expansion in air transport for passengers and perhaps for freight. Any plan for the future arrangements of London must have close regard to these eventualities. Flying, as a means of quick transport, has developed rapidly in recent years, not least under the spur of wartime emergency, and this is likely to continue afterwards. A greatly increased volume of traffic on long-distance, Continental, and overseas routes must be envisaged, and there might well be a similar or even greater expansion in inter-city traffic.

It is not possible at this stage, however, to predict future needs, nor to generalise with any certainty upon so revolutionary and rapidly changing an activity as aviation. This is true particularly as regards the more technical aspects. These are continually advancing, and the requirements of to-day might well be outdated within a short period of years. We make the suggestion that, because of the highly technical matters which are involved, and of other considerations, including strategy, climatic conditions, engine noise, possible changes in methods of landing, size of landing grounds, and length of runways, further expert opinion should be obtained as soon as circumstances dictate.

LONDON'S INDUSTRY

Engineering.—Engineering gives more employment in London than does any other industry. Except for heavy work associated with marine engineering, foundries, &c., in the riverside boroughs, this industry is continuously expanding, notably in the electrical section.

A good deal of engineering is tied to its present location by association with the Thames-side area. Other sections are fixed to localities like Finsbury by tradition and skill of local labour, whilst manufacturers of such commodities as tin boxes and cans prefer locations near the industries which use their products—in the case of tin boxes and cans, the demand comes from manufacturers of food, paint, oils, and polishes. Electrical work is very important in the eastern Thames-side boroughs, as it gives considerable employment to women in an area where most other activities, such as docking and ship repairing, employ men only.

Even making allowance for the many examples of industry rendered static by these special considerations, there remains a wide range of engineering activities offering great scope for future decentralisation. In the past few years there has, in fact, been a steady outward move of factories from Central London. At the same time there is a tendency for engineering to expand within the county, in such boroughs as Islington, St. Pancras, Wandsworth, Camberwell, and Lewisham. Further development can also be expected in Greenwich and Woolwich.

The attraction of the Greater London region for industry is shown by the fact that approxi-

mately 50 per cent. of all factories opened in the country during the years 1934–38 and more than three-quarters of the foreign firms, established in England between 1931 and 1935, were located in the London region, whilst over one-third of all new factories, with export connections, erected between 1933 and 1938, also selected London sites.

It is clear that the Greater London region offers many advantages to light industry, whether engaged in export trade or the home market, whether for foreign firms starting business in this country, for new industries generally, or for factories moving out of the congested Central London area.

This popularity is due, first, to the position London holds as the country's largest and most wealthy consumer market, where most of the new factories produce direct for the consumer; secondly, to the huge pool of skilled and unskilled labour which such a centre provides, as well as to the technical facilities, financing, and marketing to be found in a capital city; thirdly, to the excellent transport facilities between the London region and other parts of the country, principally the Midlands, from which much of the raw material comes, and to the important export facilities offered by the Port of London; fourthly, to the sight of numerous flourishing factories and the general air of prosperity associated with Greater London, which is in itself a big inducement to other industrialists to seek success in an area where the chances of failure must seem remote.

London's industry has been moving outwards for many years. It is no new phenomenon. After the last war rapid industrial expansion took place and the outward move of factories became more pronounced. Suitable sites were not always easy to find, as most of the readily accessible land near to the built-up area was being developed for houses. Hence great concentrations of factories soon began to spring up in the relatively few areas where industry could be satisfactorily accommodated. Some of the property utilised was in the nature of waste ground, unfit for residential use, or land covered with derelict Government munition factories or in some cases areas quite inaccessible and rural until opened up by the construction of arterial roads.

It can safely be assumed that pre-war tendencies will again assert themselves after this war. Following an immediate period of dislocation, a continuous and probably increasing outward move of factories to the nearest vacant land or suitable premises outside the county will set in. If not properly controlled, this will, in its turn, induce the development of further residential areas and necessitate the extension of transport facilities, resulting in an ever-extending sprawl of the Metropolis. This, at all costs, must be prevented.

Possibilities of Future Location

It is apparent that certain types of industry bearing a broad relationship to one another in similarity of site requirements have been leaving Central London, mostly for the newer industrial concentrations on the fringe of the built-up area, though some have selected existing towns approximately within a 50-mile radius of London.

The question arises, Who, in peacetime, has been determining the location of much of this mobile industry in the Greater London region? It was not usually the industrialist or the planning authority. In many cases it was the industrial trading estate speculator, and however efficiently the estates may be planned, they were not always chosen with due regard to the needs of the region as a whole.

It is probable that the decentralisation from Inner London will continue in the future. Improvement in the technique of factory estate development, with better service to industry, co-ordination between housing and factory building, which will overcome a certain past disinclination of large industrial firms to move owing to lack of housing facilities for workers in new areas, and a fuller appreciation by industrialists themselves of the advantages of clean and healthy surroundings, will all act as inducements to industry to move. Already at Elstree, one of the last pre-war industrial estates to be developed, as many as 75 per cent. of the factories were for London concerns moving out.

The future for light industry in the London region seems undoubtedly to lie with some form of trading estate. The planner, knowing the requirements of this industry, must see that the right land is used in the right place, so that method and order may be substituted for the haphazard decentralisation of the past twenty years.

Decentralisation should aim at (*a*) loosening up the congested structure of Inner London, by making land available for other purposes, principally housing and open spaces; (*b*) reducing traffic congestions, by taking away heavy industrial traffic from the town centre and residential areas; and (*c*) reducing the excessive amount of time and money now spent in travelling between residence and work place.

Broad decisions on questions of industrial policy should be made as soon as possible, otherwise haphazard factory development may continue, to the further detriment of the amenity and convenience of London's inhabitants. Unless fairly clear-cut proposals have been formulated by the end of the war, a chaotic state will result, returning industry crowding into any available buildings, including residential premises, and also seeking to rebuild on the old sites of destroyed factories, regardless of wider planning considerations.

Realisation of the Plan: Legal and Financial Aspects

We cannot fail to point out that to carry out bold and comprehensive planning, greatly enlarged powers, both legal and financial, must be made available to the public authorities concerned. Indeed, the realisation and implementation of the present Plan is dependent upon this.

The new Plan contains many constructive proposals of a type which it was not thought possible to initiate under the limited powers of the Town and Country Planning Act, 1932. These limitations arose chiefly from the uncertainty of claims for compensation, particularly in relation to those portions of a scheme which were not intended to be carried out at an early date. The Council's own difficulties arose almost exclusively from the application of planning control to developed areas. It is a matter of legal history that its planning powers in this country grew out of an Act originally intended to apply to suburban growth. The powers still retain that bias and are seen at their worst when applied to densely built-up centres of towns and the open countryside.

It is extremely difficult to make any reliable estimate of the total ultimate cost of carrying out this Plan. It is, of course, possible to ignore the policy of periodical realisation and to consider the whole as about to be carried out at one time, and to put down the cost of roads cut through built-up areas, tubes, railway rearrangements, terminals, new bridges, main sewers, water supply, &c., several hundred acres of housing estates and an almost equal area purchased for open spaces. The sum thus arrived at for the permanent improvement of London might be commensurate with the cost of the war for a few weeks. But there are several factors which must be taken into account in arriving at a more just estimate of cost. As we have pointed out, the Plan must be realised in stages, covering periods of years. It is part of the skill of the planner to arrange that each period, while contributing to the realisation of the whole, can be complete in itself, allowing for modification or even abandonment of features in the later stages. Any estimate of cost would therefore necessarily have to be based upon works proposed for the first or short-term stage.

Aluminium in Post-War Reconstruction

By ROLT HAMMOND, A.C.G.I., Assoc. M. Inst. CE..

No. III—(*Continued from page 35, July 9th*)

AN interesting example of a welded aluminium structure is illustrated in the line drawing, Fig. 9, which depicts a three-coach articulated passenger unit on the Chemin de Fer du Nord, France, constructed in 1933.[5] This form of construction is a pointer towards possible future post-war developments, for there will be an urgent need to renew much passenger stock throughout the world; indeed, the railways offer one of the most important fields for the use of light alloys, and railway engineers will doubtless be attracted by the possibility of reducing the weight of a passenger coach from, say, 30 to 20 tons.

In this particular case the complete articulated unit weighs 75 tons, and is designed to transport 534 passengers, 274 of whom may be seated. This compares with the standard steel cars, each of which weighs 43 tons, and has a passenger capacity of 188, 98 of whom may be seated. The deadweight per seat has been reduced from 440 kilos. to 275 kilos., resulting in a saving of weight of 37·5 per cent.

This design is also of peculiar interest in being of composite construction, the welded steel trussed girder underframes supporting the aluminium coach bodies. Thus both steel and aluminium have been employed to the utmost economic advantage. Careful study was devoted in this case to overcoming the difficulty of welding the aluminium alloys used, since it was not possible to submit the large bodies of the coaches to heat treatment after welding. The problem was surmounted by employing an aluminium alloy with a magnesium content of 7 per cent. Electric arc welding was applied, using an appropriate technique.

Another outstanding example of the application of aluminium alloys to structural design is provided by the booms of large excavators in the United States.[6] Reduced weight of boom permits the use of a longer boom without any resultant reduction in the cubic capacity of the excavator bucket, thereby greatly increasing the range of the machine. Furthermore, this also implies that a bucket of greater capacity for the same length of boom can be employed, whereby larger payload is handled for each cycle of the machine.

A Marion dragline excavator, employed by the MacWilliam Dredging Company for levee construction at Moreauville, U.S.A., has an aluminium boom, 175ft. long, resulting in a saving in weight of between 40 and 50 per cent. This has increased the bucket capacity by as much as 25 per cent. Long booms are found to be very useful for levee work, the advantage of extra length even outweighing that of extra bucket capacity. Fig. 10 shows an interesting comparison between a steel boom and a boom of composite construction. It will be noted that the first 35ft. length of the longer boom is built of steel, and here, again, we have a composite steel/aluminium structure in which full advantage of each material is obtained. Total overturning moment with the 175ft. composite boom is about 9 per cent. less than with the 150ft. all-steel boom. The fully rigged composite boom weighs 29,000 lb., the steel design weighing 46,000 lb. Reduction in weight is thus 17,000 lb., with corresponding reduction in the counterweight to 25,000 lb. Total weight is therefore reduced by 42,000 lb.

Greatly increased speed of excavation is claimed from the use of aluminium booms. In the case of a 175ft. boom it was found that the

[5] Article in *L'Allegement dans les Transports*, by Maurice Leroy, Chief Engineer of Rolling Stock, Chemin de Fer du Nord, Paris, 1936.

[6] Paper read before the Scottish Branch of the Institution of Structural Engineers by Edgar T. Painton, B.Sc., in 1935.

extra cost of this over and above that of a 150ft. steel boom amounted to 3500 dollars, which was paid for from the profits arising from five months' operation. In another instance, an aluminium boom weighed 3655 lb. less than its steel equivalent, bucket capacity being increased from 1¼ to 1½ cubic yard; overturning moments were 787,000 pounds-feet and 823,000 pounds-feet for aluminium and steel booms respectively.

Reduction of deadweight is also of important ance where travelling cranes are concerned. Here, again, we find an excellent example in the case of a crane in the machine shop of the Aluminium Company of America, with a span of 80ft. and a lifting capacity of 50 tons.

FIG. 11—OLD AND NEW PROPELLER BLADE FORGINGS

Instructive comparative tests were carried out by this company on three 10-ton 72ft. span travelling cranes at their Messina works. The accompanying table shows results obtained.

Such marked decrease in the power required with corresponding increase in operational speed may well justify the extra cost of the aluminium alloy structure. Another important advantage which may arise from reduced weight is the possibility of being able to install an aluminium crane on a site which might otherwise require considerable alterations to the structure supporting it.

In this country an important instance of the use of aluminium for a travelling structure is provided by the towing carriage for the seaplane tank at the Royal Aircraft Establishment, Farnborough, built of duralumin. Here the dominating factor was ease of control over a moving mass, which implied a minimum amount of inertia in the moving structure.

The Government has already stressed the vital importance of civil aviation in the post-war world, and in this development we may well expect to see striking advances in light alloy technique. Fox[7] recently referred to the engineering applications of magnesium alloys as being confined to aircraft castings for such components as landing wheels, control levers, and engine castings. Sand castings in this material are now made up to a maximum weight of 2 cwt. The petrol tanks and control surfaces of certain machines are also made. Extruded tube of this alloy is also used for pilots' seats. At present the German Air Force makes more extensive use of this material than the Royal Air Force. Robinson[8] recently gave an interesting survey of the possible future developments in the use of aluminium alloys in aircraft construction, and drew attention to some recent technical advances.

Devereux[9] has also indicated various developments which may be expected in the future in this field. He has pointed out, among other things, that the larger aero-engines of the future will require larger airscrews than are at present in vogue, and has stated that the production of a hollow propeller blade in light alloy may be the solution of this problem. He has also drawn attention to the need for tapered extrusions and extrusions that vary in sectional thickness. He describes an ingenious method adopted for providing a tapering spar boom. This involves the machining of a tee-section extruded boom to give a taper in thickness of both horizontal portions, separate machining operations giving a taper in both width and depth of the section.

The three illustrations (Figs. 11, 12, and 13), taken from Mr. Devereux's paper, show the marked improvements which have taken place in the design of aluminium aircraft components during the period 1934–39. He referred particularly to the fact that castings are being used in many parts of aircraft structures, where formerly machined or forged components were employed. An interesting example is the Phillips and Powis "Master" single-engined fighter trainer, of timber construction, which includes 360 separate castings in magnesium alloy, of which 235 are different. The propeller blade shown in Fig. 11 is another outstanding development in improved technique. A clumsy tapered slab has been replaced by a graceful forging, correct for twist and pitch to within ⅛in. of finished machine size.

The comparison illustrated by Fig. 12 shows the improved design of a hub for a variable pitch airscrew. Originally made in one stamping operation, this involved subsequent waste followed by expensive machining operations; it is now made in three operations combining stamping and pressing. Although three sets of tools are required, wastage of metal is

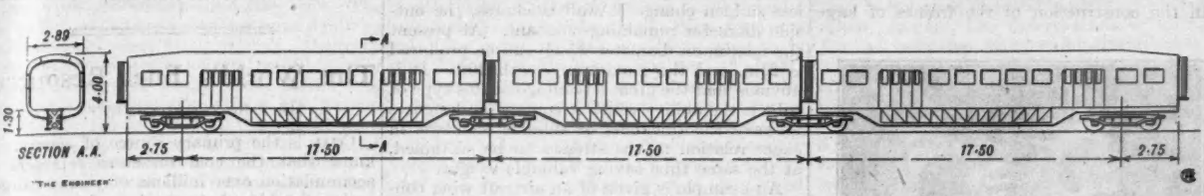


FIG. 9—THREE-COACH ARTICULATED UNIT ON THE CHEMIN DE FER DU NORD

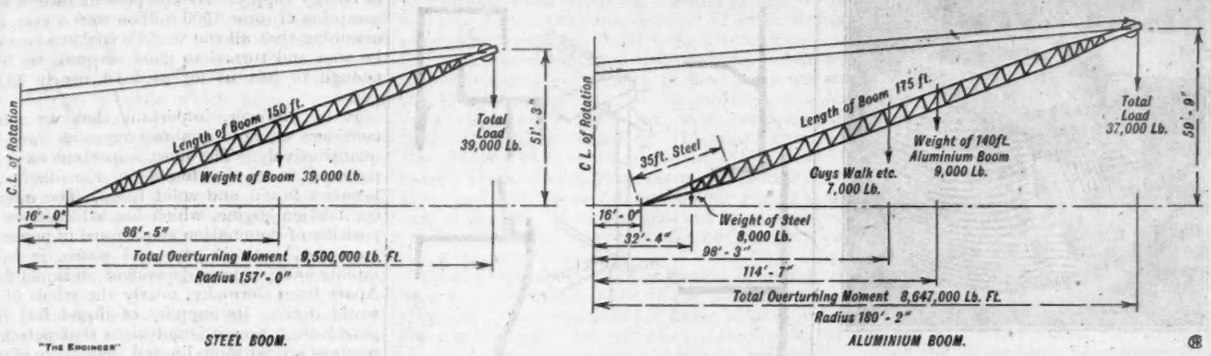


FIG. 10—COMPARISON OF STEEL AND ALUMINIUM EXCAVATOR BOOMS

Comparison of Steel and Aluminium Cranes

Crane	Design.	Weight tons.	Power used.	Speed of all-duty cycle.
I.	Steel, conventional	40	100	100
II.	Ditto, but with girders, gangway, and cage of duralumin	30	75 to 70	115 to 120
III.	Aluminium alloy throughout	21½	50 to 40	About 130

FIG. 12—OLD AND NEW AIRSCREW HUBS

[7] "Some New Developments in Magnesium Alloy Technology," by F. A. Fox, M.Sc., in *Metallurgia* for December, 1942.

[8] "Development of Aluminium Alloys," by J. Towns Robinson in *Metallurgia* for December, 1942.

[9] "Aluminium Alloys in Aircraft," by W. C. Devereux, F.R.Ae.S. Paper intended for presentation at the Second Aluminium Congress in Zürich during September, 1939.

reduced to a minimum, thus cutting down machining time and cost to a mere fraction of what it was before. Fig. 13 shows the improvement in casting design effected over the period 1934–39.

In the construction of the frames of large

FIG. 13—ALUMINIUM CASTINGS

transport aircraft of the future, great benefit should be derived from the use of taper gauge and butted tubes.[10] These are made by the Reynolds Tube Company, Ltd., and the two

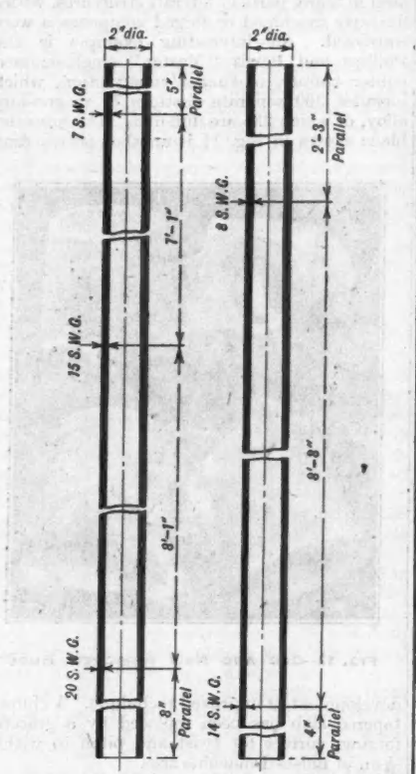


FIG. 14—TUBES OF VARIED WALL THICKNESSES

examples illustrated by Figs. 14 and 15 were produced for the Blackburn "Botha," from which it will be noted that wall thickness can be varied and parallel sections included. Outside diameter of the tube is constant throughout its length, inside diameter being varied. A butted tube is one in which there is a more or less sudden change in wall thickness, the outside diameter remaining constant. At present the maximum diameter which can be produced is 2½in. and the maximum length 20ft. It is obvious that the great advantage of this type of tube is the ability which it confers on designers to vary the thickness of tubular members in exact relation to the stresses to be sustained, at the same time saving valuable weight.

An example is given of an aircraft wing construction, where stresses are reduced towards the wing tip. A 14-gauge tube may be required at the root end and a 20-gauge tube at the wing tip, decreasing in thickness on a length of 20ft. With parallel tubes the designer would be constrained to use a 14-gauge parallel tube throughout, or four parallel-gauge tubes each 5ft. long

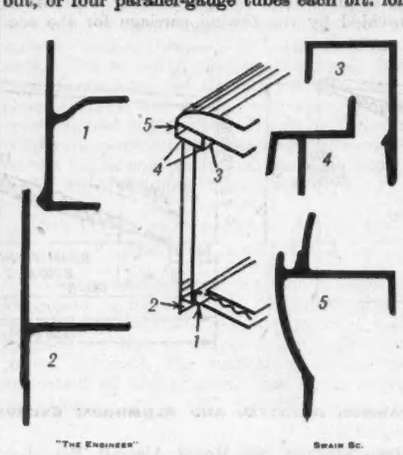


FIG. 15—EXTRUDED SECTIONS FOR BODYWORK

in 14, 16, 18, and 20 gauges, provided with a joint at each change of gauge, thus entailing extra time and cost. Using the taper gauge tube, one tube only is required, tapering gradually along its length. Other obvious uses for taper gauge tubes are for wing spars, stringers, tail plane struts, axle tubes, and oleo legs. In the author's opinion, these tubes should have a great future in the development of civil aviation.

For more than twenty years aluminium panels have been employed for the bodywork of commercial motor vehicles.[11] Fig. 15 shows the manner in which extruded sections can simplify construction. These sections combine structural rigidity with excellent appearance, since they are both load-bearing members and mouldings. The corrugated aluminium floor is stated to be 20 per cent. lighter than a corresponding flat aluminium plate floor, and about 60 per cent. lighter than a floor of flat steel.

An interesting example of the use of aluminium for the construction of the bodies of heavy vehicles is provided by those fitted to the trucks used in the construction of the Boulder dam. These were 6060 lb. lighter and carried 2 cubic yards more material than the equivalent steel trucks. Again, in Germany a bus was constructed with an aluminium body, the total weight of the vehicle being 6½ tons, as against a weight of 9 tons for the equivalent steel bus. This substitution effected a saving of 2·4 million horsepower-hours, equal to 4600 gallons of petrol in acceleration alone over a period of four years, in addition to a further saving of twenty-five tyres over the same period.

CORRECTION.—In our article "Aluminium in Post-war Reconstruction" (issue of July 9th, page 34), the blocks for Figs. 6 and 8 were transposed. The illustration showing a man at work is that of the Metrovick aircraft spot-welding machine, of which Fig. 7 illustrates the electrode guide block. It is worth while further pointing out that the machine illustrated as Fig. 6 should have the caption "Air-operated Welding Machine," and is a special machine for welding small-diameter aluminium ductings.

(To be continued)

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[10] "Taper Gauge and Butted Tubes," article in *Aircraft Production* for January, 1942.

[11] "The Use of Light Alloys in Structural Design," by W. C. Devereux, F.R. Ae. S., Vol. XXXII of the "Proceedings" of the Institution of Automobile Engineers.

The World's Fuel Resources*

By J. G. BENNETT

COAL is the primary source of energy. We know that the coal measures represent the accumulation over millions of years of organic carbon fixed by photo-synthesis from the carbon dioxide of the earth's atmosphere. We know that the supplies of coal are not inexhaustible, but when we think of the estimated world reserves of between 10 and 15 million million tons, according to the method of computation, we are inclined to think that this generation at least need not concern itself with the question of energy supply. At our present rate of consumption of some 1500 million tons a year, and assuming that all the world's coal reserves can be won and turned to good account, we have enough to last us for at least nearly 10,000 years.

It is, however, important that we should consider energy qualitatively, as well as quantitatively. The most important example, perhaps, is to be found in the distinction between liquid and solid fuels. The internal combustion engine, which has attained such a position of domination as a source of power for transport, both in war and peace, is to all intents and purposes dependent on liquid fuels. Apart from Germany, nearly the whole of the world derives its supplies of liquid fuel from petroleum. Now it is notorious that petroleum reserves are far more limited than those of coal. On the other hand, they are more difficult to estimate, because pools of oil in the majority of cases cannot be discovered from surface indications.

It is clearly of major importance from the point of view of coal research to know whether or not the large-scale production of oil from coal is going to be necessary within the present generation. I have therefore endeavoured to estimate the world's ultimate reserves. This is a very different thing from the proved reserves which have been verified by actual drilling. If we take the proved reserves first we have to turn almost entirely to the United States and Russia, where the greater part of the exploratory drilling has been done. The latest figure shows a total of some 30,000 million barrels, or 5000 million tons. This is sufficient, at the present world rate of consumption, for twelve years ahead. There must be, of course, immense undiscovered oilfields, and the problem is to estimate the amount of oil present in sufficient concentrations to be worth recovery and down to a depth at which drilling is feasible. Mr. Wallace Pratt, geologist of the Standard Oil Company of America, one of the world's greatest authorities on the subject, has estimated that the ultimate reserves of the world may amount to 600 thousand million barrels, sufficient at the present rate of consumption of liquid fuels to supply the world's needs for 250 years. He has, however, pointed out that the rate of discovery of new oilfields is not keeping pace with consumption, even in the United States, and that, in the rest of the world, prospecting for petroleum is making so little progress that a world oil shortage is threatened quite apart from the question of ultimate reserves.

Apart from this, I think that Pratt's own calculations require some modification. They are based on the assumption that new oilfields to be discovered will yield the same average production as the areas of the United States which have already been thoroughly explored, such as the States of New York, Pennsylvania, West Virginia, Ohio, Oklahoma, and California. Now it is obvious that on the whole it is the large and well-marked oilfields which are most likely to be discovered and that, as time goes on, new oilfields will grow less and less rich.

* From an address to the British Coal Users' Research Association at a conference on "The Ultra-fine Structure of Coal and Coke" held at the Royal Institution on June 23rd and 24th.

This is confirmed by the falling yield of new wells brought in in the United States over the past ten years.

I hope you will bear with me while I make a few simple calculations. Oil occurs only in certain types of marine sedimentary rock. The land surface of the earth contains some 6 million square miles of these types of rock. Contrary to older beliefs, it is now known that oil-bearing rocks cover a wide range, from tertiary to cretaceous, and our calculations are greatly facilitated by the fact that all these rocks have been thoroughly explored in different parts of the United States. The average proportion of oil-bearing land to the total marine sedimentary strata seems to be fairly constant for all the different regular types between 1 and 2 per cent. We may therefore assume about 100,000 square miles of land actually oil bearing throughout the land surface of the earth. Now we should not be right to assign to the whole of this area the same productivity as the fields fully explored in America. I have accordingly divided oil-bearing land into three categories: rich oil-bearing lands, medium oil-bearing lands, and poor oil-bearing lands. I have estimated that the percentage of each category likely to occur in all types of marine sedimentary rock and obtained an average which agrees with the areas thoroughly prospected. From these figures it is easy to calculate that the world's oil reserves should be about 300 thousand million barrels, or some 50,000 million tons. This seems a large enough figure until we stop to reflect that the world is at present consuming about 400 million tons of oil a year, and that consumption has risen steadily for the past hundred years, through war and peace, through boom and slump.

It is hardly conceivable that as the oilfields of the rest of the world come to be exploited as intensively as those of America, the consumption of petroleum in those countries should not also rise, if not to the high figure of 11 gallons per head of population which obtains in America, at any rate to something higher than the present average of 1 gallon per head of population for the whole world. I think we must expect the world's oil consumption to rise at least to 4 thousand million barrels a year. We must also recognise that it is scarcely likely that the whole of the world's oil reserves can in practice be recovered and turned to account. Where small oilfields lie at a great distance from points of consumption, the construction of a pipe line to transport the oil may not be practical politics. It seems to me that we must allow for at least 15 per cent. of the world's oil remaining in the earth. This gives us something like 250 thousand million barrels of actually available reserves, or a life of the world's oil supplies of something between sixty and a hundred years, according to the rate at which consumption grows.

I should not fail to mention that, apart from the "free" or liquid oil reserves to which I have been referring, there are also very great quantities of oil sands and oil shales throughout the world. These are not at present economic to work in most cases, but as free oil supplies diminish they will no doubt be used. They will not, however, absolve us from the obligation of producing oil from coal.

Much the same arguments apply to the lignite and brown coal deposits which exist in enormous amounts in the North American continent, in Europe, and in Australia.

This is not all, for oil production requires prospecting, and, as I have said before, no country in the world is carrying on the search for oil with an intensity comparable to that of the United States. Even in Soviet Russia, where the whole resources of the State are behind the search for oil, only two to three thousand wells were sunk annually before the war. In America between twenty and thirty thousand wells a year are drilled by private enterprise—far greater than the whole of the rest of the world put together. Unless the supply of oil geologists can be stepped up at a great rate, and unless the other countries of the world take prospecting for oil far more actively in hand than they have done in the past, we shall run into an oil famine long before the world's oil reserves really begin to run low.

It seems to me, in fact, that the critical period may come upon us very soon, and in this connection I would like to quote a most remarkable address given a few weeks ago by Mr. Ickes, the Secretary of the Interior of the United States, who is also Petroleum Administrator and Solid Fuels Co-ordinator for War. He points out that ratios of 1942 output to reserves in the United States are:—For coal, 1 : 3830; for natural gas, 1 : 32; for petroleum, 1 : 14.

For petroleum, additions to proved reserves for the past few years have been only one-third of the annual consumption. Mr. Ickes therefore thinks that the need to produce liquid fuels from coal may be felt very soon, even in the United States, and says that he hopes that the United States Department of the Interior will lend an official hand in the establishment of these new industries based on coal.

We know that the production not only of liquid fuels, but of other chemicals from coal, is already practised on a very large scale in Germany and we know how important this is for Germany's war potential. I would go further and say that if the same amount of scientific research and chemical engineering development had been put into oil from coal processes as has been devoted to the refining of petroleum, we should to-day be producing our liquid fuels at a price which, allowing for tax, would compete effectively with imported oil. In saying this, I would have you bear in mind that, in the past twenty years, the American petroleum industry alone has spent over £50 million on research and engineering developments, and at present employs a scientific personnel of more than 5000 engaged on research.

I have referred to the production of liquid fuels as one example only of the increasingly important place which coal is likely to occupy in world economy. I should like you to consider also the still wider question of energy in general. By far the greater part of the energy requirements of our industrialised civilisation are supplied by coal, including lignite. Coal supplies more than three times as much energy as petroleum, natural gas, water power, and other sources of energy put together. It is important to get a correct perspective about water power, which really represents a very small proportion of the world's energy supply. Less than one part in a thousand of the world's total output of energy is derived from water power.

It is sometimes said that the disappearance of our coal reserves need not cause concern for the well-being of our descendants, for future generations will be able to capture energy directly from the sun, or even to use the energy of atomic disintegration. On the latter subject many wild statements have appeared in the popular Press. I need hardly remind such an audience as this that we have at the present time not the slightest indication in any physical laboratory in the world of a process being developed which could conceivably provide us with great quantities of energy from atomic disintegration. An interesting article by Professor Millikin in a recent number of *Nature* suggested that the release of energy by the annihilation of atoms is possible only in interstellar space.

It seems to me that trying to get energy from the atom under terrestrial conditions is rather like the famous problem of finding a needle in a haystack—it is true that the lucky shot may give you an immense return, but there is so far no indication that the odds against success do not far outweigh the possible benefits. It may even be that our physicists will come to recognise that this is no mere accident of engineering construction, but inherent in the very nature of atomic structure, and that it will be about as easy to make a net profit out of atomic disintegration as it would be to get into yesterday by travelling with a speed exceeding that of light. Our ancestors believed that one day the secret of perpetual motion would be discovered. We now know that more than one kind of perpetuum mobile is impossible.

Setting aside hopes for which at present no conceivable justification can exist, let us turn our attention to the problem of fixing the sun's energy as it reaches the surface of the earth. This has been fairly extensively investigated, particularly at the Massachusetts Institute of Technology, and Professor Hottel, of the M.I.T., has recently published an account of our present knowledge of the subject. Without going into detail, I will give you his figure for a solar energy trap in the most favourable place which can be taken, namely, the desert lands of Arizona. For an effective engineering installation he calculates that 40 H.P. per acre could be obtained throughout the year. Here in London, with our northerly latitude and many days of cloud, we should be lucky to get an effective 5 H.P. per acre. This would mean that the electrical requirements of London alone could only be met if the whole of the Greater London area were converted into a sun trap. There is, moreover, one serious defect of any process which produces energy only when the sun is shining, namely, that to give a regular supply through the twenty-four hours, energy would have to be stored, and we have at present no satisfactory means of storing immense quantities of electrical or thermal energy, except in the form of fuel. We must also remember that anything in the nature of a solar energy trap requires an expenditure of material and labour far greater than installations for converting energy stored up in the shape of coal or oil. Very similar considerations apply to the utilisation of energy from the tides or from the winds.

The conclusion to which one comes in surveying the world's reserves of energy is that coal, and coal alone, provides the one reliable, stable reserve to which our industrialised civilisation can turn. It may well be that unless the question of energy reserves is taken seriously in hand, our descendants may have to face an energy famine which will create social problems utterly unlike any which have yet been known in the history of the world. We must also remember the dependence of modern nations upon energy for their political influence in peacetime and their power of waging war. It seems to me that one of the most urgent problems of this generation must be to provide the means of preserving for our descendants the sources of energy they will need if they are to enjoy the doubtful benefits of a mechanised civilisation.

I am sure that you will forgive me for these rather wide excursions into the field of world energy reserves, in which we have talked in terms of thousands of millions of tons, and that you will not have failed to see their bearing upon our discussions during the next days. We now have to think in terms of units weighing less than a thousand billionth of an ounce to explain the structure of coal and its industrial behaviour. Such is the vast sweep in scales of magnitude which our minds must embrace if we are to understand rightly the problem of coal and its utilisation. I firmly believe that one of the keys to our future prosperity is a right understanding of the nature and structure of coal, for this will enable us not only to utilise it to the best advantage as a source of energy, but also to convert it into the innumerable carbon compounds which are becoming more and more essential to our modern life.

It is very usual to speak of the end of the age when coal was treated merely as a fuel, and the beginning of a new age when coal will be regarded as a raw material of chemical industry. We must recognise that this epigram is not rightly stated. Coal can never cease to be primarily a fuel, that is, a basic source of energy. I hope I have convinced you that the world has no other in sight.

Our problem is so to treat and deal with coal that we can extract from it those valuable constituents which are required for our chemical industries, without detracting from its effectiveness as a source of energy. Hitherto the main process which has rendered possible the simultaneous realisation of these two aims is carbonisation; that is, the manufacture of gas and coke. For this reason it is appropriate that the present conference should be concerned with the fine structure of coke as well as coal. I believe, however, that carbonisation is but one of many processes which we shall learn to use for deriving simultaneously from coal both chemical materials and also energy.

The Engineer

JULY 23, 1943

VOL. CLXXVI No. 4567

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EMPLOYMENT POLICY

LAST week we completed our presentation of excerpts from a Statement on Employment Policy made by a conference of Nuffield College. Long as our excerpts, made by the courtesy of the Conference, are, they represent but a fraction of the whole, but in preparing them we have endeavoured to select such paragraphs as would represent, in its own words, the policy of the Conference. If we have succeeded in that duty our readers can scarcely fail to notice that this statement differs in many respects from the all-too-numerous plans for reforming industry which have preceded it. Many of the earlier outpourings have been notable rather for "must and wrath" than for sober thinking. There is in them too much insistence on a particular plan, too much "this must be done, this practice must be proscribed, these people must go," and too much wrath with those whose views are not those of the authors. Just because the Statement is moderate it carries weight which is denied to *ex parte* fulminations. Its breadth of treatment is the immediate and probably inevitable result of the composition of the Conference. At it there attended representatives of "a wide variety of attitudes and experiences," and it "included many who in other capacities have been associated with the widely divergent policies of different parties and groups." Thus views of all sides of the question raised were taken, and on the Drafting Committee, which prepared the statement, lay the duty of presenting a composite picture of the opinions of those, over thirty in number, who attended the meetings.

The principal thesis which the Conference discussed was the achievement of the nearest possible approach to full employment at a high and steadily rising standard of living. One is justified in believing that employment is very generally regarded as an end in itself. That, says the Conference, is to fall into "the perilous fallacy that employment, and not production of useful things, should be the object of national economy." In this connection it is attacking the common argument that since distribution gives employment, it should not be regarded as wasteful. Now there is no manner of doubt that many distributive agencies have been set up primarily for the purpose of giving employment to the founders of them. The man who opens an agency does so because he wants to make a living for himself. In doing so, he must engage the services of others, and by degrees the business may expand into very large proportions, be copied by others, and provide profitable occupation for very many thousands of men and women. If it be the "national economic policy" to reduce greatly the numbers so engaged, can employment for them in the "production of useful things" be found? That is really the crux of the matter. The primary problem of unemployment is that of creating such a demand for useful products that everyone may at all times be usefully engaged. All the other problems are secondary to that problem. They are all concerned with means for facilitating demand and the removal of practices which are held to restrict demand. It would appear, *a priori*, that employment brings its own demand; that if enough people are gainfully employed they will always support a market for the goods they produce. That was the principle that Henry Ford advanced when he asserted that his own workpeople were his best customers, and was advanced at one time as the Secret of High Wages. Experience has shown that it does not work out quite as well as expected. Something goes wrong, and the whole train is thrown out of gear. Cyclical unemployment often follows and a slump occurs. It is now believed—the Statement reflects that belief—that international arrangements after the war will avert the repetition of such tragedies. "If the leading nations act together," says the Statement, "there is no reason why they should not succeed in reducing cyclical unemployment to very much smaller proportions," and it proceeds, as those who read our excerpts will see, to suggest various courses which the nations ought to pursue with this object in view. But it is worth noting that the Conference is not over-sanguine about the complete success that can be attained; it speaks only of "very much smaller proportions," not of complete elimination. To facilitate international action, and domestic action also, it is held that the Government must have a general economic policy. In settling this policy the Government must have the advantage of the advice of industry. To crystallise this advice, the Statement makes the recommendation that Public Industrial Boards should be brought into existence, and should be recognised by the Government as the bodies with which it would deal in all matters relating primarily to the industry concerned. The Statement does not advance this as a new idea, and the Conference was, no doubt, not unmindful of the numerous trade organisations, chambers of commerce, employers and labour federations, and so on, which already put their views before the Government. But the Industrial Boards which it visualises would have greater powers than existing organisations and it is expressly stated that their primary purpose should be "to promote the fullest possible efficiency in every section of the industries concerned."

The Statement so bristles with acute observations and provocative conclusions that we could spend all day discussing it. But we have done a better service in placing the gist of it before our readers, and we shall have done a still better if by the course we have taken many are led to read it in full for themselves. If it is less constructive, less "blueprinty," than many that have preceded it, it is more tolerant, more wide-seeing than most of them. It is, we suggest, rather a survey on which policy can be built than a policy itself.

Cast Iron and the Spectrograph

A PAPER by Messrs. Ling, McPheat, and Arnott, which we reprint in this issue, describes the analysis of cast iron by the use of the spectrograph. It is just over a hundred years ago since the first photographs of a spectrum were obtained by E. Becquerel and J. W. Draper independently; W. H. Fox Talbot had already, in 1834, clearly envisaged the possibility of spectrochemical analysis when, referring to lithia and strontia, he said:—"Optical analysis can distinguish the minutest portions of these two substances from each other with as much certainty, if not more, than any other known method." The delay in applying to industry a discovery made so long ago has often been the subject of comment, but it must be admitted that a great development in instruments and technique had to be effected before that discovery could be embodied in a form appropriate to routine industrial work.

It is not so easy, however, to find a valid reason for the lack of interest among the iron and steel manufacturers of this country in a

method of analysis which has been so widely utilised during the past fifteen years in the non-ferrous metals industry. The cast irons are very important industrial materials, and the properties peculiar to each variety depend, not only on the carbon, phosphorus, and sulphur which are not yet within the scope of practical spectrochemical analysis, but on silicon, nickel, manganese, chromium, and molybdenum, which are. Chromium and molybdenum are used to give increased hardness and wear resistance to high-quality cast irons, while nickel improves the strength without an appreciable increase of hardness. Other properties, such as machining ability and liability to chilling at the corners, are also affected if the percentages of the constituents are not kept within limits. Again, relatively small percentages of some elements, such as chromium, if present accidentally in malleable cast iron, interfere with the operation of malleablising. There is good reason also to believe that some, at any rate, of the trace elements are important—for example, cast iron containing small amounts of titanium under certain circumstances may give super-cooled graphite instead of the normal black graphite. To-day, specifications for cast irons give fairly close limits on constituents. For example, taking the well-known Air Board Specification D.T.D.485, we find the following laid down :—Silicon, from 2·1 to 2·7 per cent.; manganese, from 0·5 to 1·2 per cent.; chromium, from 0·8 to 1·2 per cent.; molybdenum, from 0·6 to 1·2 per cent. These specification figures would be regarded as fairly wide, but makers actually work to considerably closer ranges, for if an iron like that mentioned above had chromium and molybdenum at their top limits and carbon and silicon at their lower limits, the resulting castings would be quite unmachinable. Makers are therefore faced with the necessity of making many analyses per day ; thus the spectrographic method, which in routine work requires less than a quarter of an hour for determining all these constituents in a specimen, as against perhaps an hour by chemical analysis, has very important advantages. To obtain the analysis of nine samples of cast iron for the five substances mentioned in 2½ hours (as the authors are able to do without in any way pressing for speed) should be of great utility in maintaining the reliability of a given type of cast iron.

The Institute of British Foundrymen has done valuable service by bringing this matter before its members, and perhaps it is not too much to hope that some British foundries will now have the enterprise to adopt a procedure which has for its object, not merely to pass or reject to specification as many specimens as possible in a day—which is the object aimed at in this country—but to achieve such reliability of manufacture that analysis is unnecessary ; that is, to ensure that the metal is right and not to defer the test until a stage when nothing can be done except to reject what is not within specification. At various foundries in America specimens of cast iron are taken from the crucible, chill cast, and spectrographically analysed in a total time of six and a half minutes from molten metal to the analysis of the chromium, copper, magnanese, molybdenum, nickel, and silicon. By these means the molten metal is kept within the specified limits, the slow changes in the percentages of the various constituents being corrected under the control of continuous spectrographic analysis. The paper we reprint may do something to encourage the spread of that practice in this country.

Post-War Employment

THE decision of the Minister of Labour and National Service, as reported in our last issue, to appoint a Committee under the chairmanship of Lord Hankey "to consider and report upon the arrangements which should be made to facilitate the employment after the end of hostilities of men and women qualified to undertake responsible work in the professions and elsewhere," is one that had been expected. For the problem of "demobilising" into civil employment the large numbers of professional and other men and women that have been drawn into war service is not going to be easy to solve and needs study before the occasion for it arises. The membership of the Committee has clearly been so chosen that the Dominions and Colonies, educational establishments, commerce, industry, and labour shall all be represented.

While the general terms of reference of the Committee are wide enough to cover all kinds of professions and vocations, they are qualified by particular reference to "the organisation, premises, and staff of the Appointments Department of the Ministry of Labour and National Service ; and the arrangements which should be made for co-operation between the Appointments Department and other organisations and institutions (including professional, industrial, and commercial organisations) and universities at home and abroad." This fact has suggested to the daily Press that the Committee is to deal more particularly with the matter as it concerns those with a technological or scientific training, and will thus have a much narrower field. We regard it as regrettable in any case that the major technical institutions are to be unrepresented upon a Committee which seems certain to deal with matters that concern them. But if the studies of the Committee were to be restricted to the narrower field, the omission of representatives of those institutions and the inclusion on the Committee of at least two representatives of organised labour would become additionally strange. The terms of reference of the Committee are, however, so vague that it is difficult to give critical consideration to its composition.

Obituary

LIEUT.-COLONEL WALTER BRIDGES

IT is with deep regret that we have to record the death of Lieut.-Colonel Walter Bridges, which took place on Wednesday, July 14th, at his home, "Stretton," South End, Bradfield, Berks. He was the principal of Walter Bridges and Co., consulting and supervising engineers, of 37, Parliament Street, Westminster, and was chairman and managing director of the Projectile and Engineering Company, Ltd. He was born in 1872 and in 1891 was articled to James Simpson and Co., waterworks engineers, and from 1896 until 1903 served as assistant engineer to the firm. He then entered into partnership with the late Mr. Hal Williams as a consulting engineer. In 1910 the partnership was dissolved and the firm of Walter Bridges and Co., consulting and supervising engineers, was founded. In 1912 he designed and erected the new works for the Diesel Engine Company at Ipswich, which in later years was taken over by Vickers and Petters. Work for the same clients included advisory work in connection with the oil engine driven pumping station erected by the company at Gladstone Dock, Liverpool, for the Mersey Docks and Harbour Board. He was also responsible for the design of the oil engine generating section of the Chelsea Electric Lighting Company, in which special anti-vibration concrete foundations were laid down. Other Diesel Engine Company work included numerous power schemes and irrigation works in Egypt.

During the last war Walter Bridges saw service with the Royal Artillery, in the Field Artillery, and Siege Artillery, and he was commissioned in the Royal Engineers with the rank of Lieut.-Colonel. Later in the war he was transferred to the Ministry of Munitions, serving under Sir Alexander Walker and the late Lord Stevenson. He also served on the National Salvage Council and had to do with waste Army products. After the war he was appointed consulting engineer for the Clyde Navigation Trustees. Amongst his principal undertakings were the progressive reconstruction and reorganisation of the marine engine works of David Rowan and Co., Glasgow, and the new works of the Manganese Bronze and Brass Company at Ipswich.

Colonel Bridges found time for much expert witness work in connection with engineering litigation and arbitration, and took part in many inquiries held under the Ministry of Health and the Ministry of Transport, the Board of Trade, and the Electricity Commissioners. He was also connected with a considerable number of local authority schemes and Parliamentary Bills.

He was a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, and the Institution of Structural Engineers, besides belonging to the Royal Sanitary Institute and the Association of Consulting Engineers.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents).

THE DUNLOP SUGGESTION SCHEME

SIR,—Other large industrial organisations, including a Government armament works, have interested themselves in studying the technique (of which we are amongst the pioneers) which we adopt of pooling the day-to-day experience of our workers for the common good. Many suggestion schemes are known, but it is possible that the results secured by ours may commend the idea more widely and so make a practical contribution to the war effort.

In the last six months, probably 50 per cent. of suggestions sent in by our employees have been carried into effect. They came from every grade of worker and are considered by a special committee composed of representatives of the engineers and rubber workers and the staff. The chairman, secretary, and technical experts are appointed by the management.

It is important that employees should have confidence in the committee.

Suggestions are written and placed in boxes in the different departments. They may be anonymous in case a man feels that his suggestion is a criticism; but, in fact, hardly more than 1 per cent. are anonymous.

There are people who are diffident about writing and many who cannot explain their ideas properly. Any suggestor can get assistance in such cases by consulting the committee secretary.

Suggestions deal with a wide range of subjects, amongst which amenities and well-being, saving of time, economy of materials, ideas regarding plant or processes, avoidance of waste, and safety are prominent. They often give a useful indication of personal initiative and may sometimes point to the need for examination of conditions which seem remote from the suggestion itself.

Some suggestions may save money and others may involve expense. There is no fixed scale of awards, but the committee finds it of great encouragement value to allot a substantial number of awards, even though the amount per award may not be high.

Considerable importance is attached to the maintenance of interest in the suggestions scheme as part of a general plan for promoting good relations, and I shall welcome the opportunity of giving fuller details to any industrial organisation which may be interested.

W. BOND, Chairman,
Fort Dunlop Suggestions Committee.
Birmingham, 24, July 17th.

SIXTY YEARS AGO—AN ELECTRIC LAUNCH

SIR,—We were extremely interested in your usual article, "Sixty Years Ago," in the current issue concerning an electric launch which we, in conjunction with Messrs. Yarrow, supplied in 1883, as we have long since lost most of the details. This, however, was not the first venture in this direction, as we find that in 1882 this company purchased a tugboat built by Messrs. Yarrow, which, after being stripped of engine and boiler, was fitted with motor and an E.P.S. battery and renamed "Miss Electricity."

This craft was 26ft. long and 5ft. beam, with a draught of 2ft. The battery of fifty cells weighed 2700 lb., and when discharging at 30 amperes for ten hours a speed of 7 m.p.h. was obtained from a 3 H.P. motor and a 22in. bronze propeller.

"Miss Electricity" made its début on the Thames with Professor Silvanus Thompson on board on the same day in February, 1883, as saw the first electric tram powered by E.P.S. batteries in operation on a West London horse tramway track. "Miss Electricity" was also the subject of considerable interest and speculation as to the nature of its motive power when it appeared on the river during the Oxford-Cambridge boat race in April, 1883.

In the same year a Carvel-built mahogany launch, designed to carry forty passengers and equipped with a special galvanised steel propeller, was shipped for use on the ornamental lake at the Vienna Exhibition, being first steered by the ill-fated Crown Prince Rudolph of Hapsburg. Its reliability in respect to range was afterwards demonstrated to foreign journalists and others by a 50-mile trip on the Danube from Vienna to Pressberg.

The latter is the launch to which you have made reference, but the only information we now possess is that it was the first of these craft to be fitted with a steel propeller, previous experience having shown that bronze propellers were unsuitable with propeller shafts at high speeds.

It is interesting to note that two years later a cross-Channel passage from Dover to Calais was successfully completed, the launch being under the care of the same pilot who accompanied Captain Webb on his first Channel swim.

PRITCHETT AND GOLD AND E.P.S. COMPANY, LTD.,
J. W. B.

Dagenham, July 16th

THE S.B.A.C. AND CIVIL AVIATION

SIR,—The space which THE ENGINEER has devoted during the past few months to post-war air transport, and your public-spirited editorial comments on the subject, impel me to ask the courtesy of your columns to enlarge on some points in your leading article of July 2nd, in which you examined the Society's memorandum entitled "The Future of British Air Transport."

In some respects you appear to do less than justice to the Society's proposals and to the motives and intentions underlying them. While you are correct in saying that the members of the Society have the responsibility of endeavouring to maintain the highest standard of employment in the British aircraft industry, they are also deeply concerned with the welfare of British aviation as a whole. They believe that aviation has an importance to the British Commonwealth and Empire which is complementary to the admitted vital importance of the Mercantile Marine. Had this country given the same consideration to air power that it has to sea power, it is by no means improbable that the present war would not have had to be fought. Even if it were to be assumed that supreme air power may not be necessary to us after the war, there will still remain the great advantages which the more intimate contacts made possible by the speed of air transport will offer in integrating the divergent problems of the Empire and of the other countries with whom we must work and trade to live.

The high population density of this country necessitates, if we are to have our fair share of the world's wealth, that we should provide from our own efforts those services which our tradition and training enable us to give effectively. In the future, air transport will not be the least of these. As the memorandum declared: "The British national genius has always found a medium of high expression in the art and science of transportation."

It is difficult to concur in the view that adoption of a monopolistic policy is a purely domestic question. Existence of a single State-subsidised monopoly company appears to us certain to breed suspicions that the company's operations are so closely linked with the State that military and other considerations altogether remote from economic and commercial operation of air lines must exert a large influence over its policy and activities. It seems much more unlikely that such suspicions would be aroused by the operations of a number of independent companies, operating on a similar basis to our great shipping lines and with the minimum interference and control from the State.

Undoubtedly, as you point out, the difficult question of monopoly is linked with the still thornier problem of subsidy. The Society holds that ideally subsidies should be rendered redundant by the economic improvement of aircraft to the point where they could operate profitably without subsidy, and aeronautical development is tending in that direction, even for many kinds of cargo as well as for passengers and mails. Nevertheless, this country must face the difficult process of changing over from war to peace, which is almost certainly beyond the capacity of private enterprise. For that reason, and as a short-term policy, some recourse to the national pocket appears inevitable. And here the Society's proposals are expressly directed towards lessening the evils and dangers of State-aided international air transport competition. To receive payment for services rendered in the face of competition, it is necessary that the services should be performed efficiently; to receive a subsidy, the form of air transport alone is necessary—and not the substance. The Society's proposal—which your leading article does not mention—to give the fullest publicity under the ægis of an international controlling body to the audited financial operations of companies allowed the freedom of international transit, is the most effective check against abuse and a strong bulwark against air aggression in the guise of air transport. Publicity on this subject means peace.

The State provision of navigational aids which the Society suggests is not dissimilar to facilities already provided for shipping, and as these are available to all international traffic they can hardly be considered as promoting individual and selfish interest.

Suggestions that a directly subsidised monopoly would provide equivalent services to those provided by freely competing organisations are not in accord with history. The historian Gibbon, writing of monopolists, said: "The new improvements so easily grasped by the competition of freedom are admitted with slow and sullen reluctance in these proud corporations, above the fear of a rival and below the confession of an error." Important developments in aircraft design that are now common features of the modern aeroplane and so many of which have been in recent years brought to fruition in the United States of America were the direct result of the competition of commercial air lines in that country.

The aircraft industry's experience of the working of a "single chosen instrument" policy during the past twenty years has not been happy. That policy led to technical stagnation in some most important fields of air liner development, and, except in the smaller categories of aircraft, to the virtual extinction of the British air transporter manufacturing industry. Not one metal aeroplane built to Imperial Airways specification was ever sold to another operator. In these circumstances the industry must find it difficult to believe that from now on monopoly may be trusted to achieve what it has so signally failed to achieve in the past.

E. C. BOWYER,
Chief of Information Department.
The Society of British Aircraft Constructors,
London, W. 1, July 20th.

South Africa's Oil Prospects

THE Union Government is now taking up in earnest the prospecting of certain areas in the Union in the hope of striking an oil deposit in one or more of the localities. In the House of Assembly, early in April, the Minister of Mines stated that about ten bore-holes would be sunk "in a certain district" this year. After that had been done the Government would be better able to assess the possibilities of obtaining oil. From the Minister's use of the phrase "a certain district" it may be assumed that the Government are in possession of some information that the "district" offers reasonably good prospects of yielding oil in satisfactory economic quantities. The progress of the operations will be followed with great interest, as it is easy to see what a large addition it would be to the prosperity of the Union if oil in large quantities was tapped. So far there have been no discoveries of oil in the Union, two or three announcements in the past having been found to be false alarms. The most promising indications of oil, so far published, have been found in Portuguese East Africa.

The Principles of Employment

WE print below excerpts from a pamphlet recently issued by the Dominion Engineering Works of Canada. This pamphlet is characterised by clarity and by its clear-cut concentration on its objective. In many respects it is opposed to a considerable body of present thought in this country, but it advances arguments that cannot be idly dismissed. Our excerpts have been selected to exhibit those arguments.

Regardless of what kind of social system we live under, we are dependent upon new capital formation for the attainment of full employment and a rising standard of living. All our industrial capital, our tools, including the whole of our vast industrial machine, have been created from the very beginning of time by saving labour from current production and converting it into improved means of production. That is why from the earliest times the habit of thrift has been regarded as a virtue. All social progress has resulted from thrift. It is thrift, that is spending less than our income or, to put it another way, consuming less than we produce, which has brought us from the condition of the Stone Age to our present relatively high standard of living.

All production of finished goods may be divided into three broad classes:—

(1) Consumer goods.
(2) Consumer durable goods.
(3) Producer or capital goods.

The first is not capable of much contraction or expansion over any short period of time so far as employment is concerned without changing substantially our present manner of living.

The second, that is, consumer durable goods, is capable of expansion, limited only by our ability to produce because, as previously stated, production creates its own purchasing power to take off the market what is produced.

* * *

There is a feeling, unfortunately quite general, that adequate employment after the war can only be provided by the continuation of large expenditures by the State to be financed by the maintenance of high taxation. This may be necessary to carry out an orderly transition from a war to a peacetime basis, but it is not in the interests of the people of Canada that this should be continued for a day longer than necessary. The State can only convert savings into capital investments of indirect benefit to production. If the State should attempt to assume the responsibility for the conversion of savings into capital investments for direct production, it would naturally follow that the State must assume responsibility for the planning of production itself. Such central planning would call for a degree of regimentation and taxation which the people of this country would not tolerate in peacetime. It is possible only under a dictatorship or totalitarian form of State or in a democracy during time of war, when people are willing to give up their freedom in order to win the war.

It is a more reasonable view that the need for Government-produced employment could be substantially reduced, and perhaps eliminated within a relatively short time, if the Government will, by its present and future policies, encourage the accumulation of savings and their conversion into capital investment by private enterprise when needed to provide employment. There is no reason why the responsibility for providing employment should not be shifted to private enterprise immediately after the termination of the war if the Government will co-ordinate its post-war plans with the post-war plans of private enterprise. Any such co-ordination of plans necessarily assumes that the Government's post-war policies will produce conditions favourable to the expansion of enterprise.

* * *

A good illustration of what takes place when there is a sufficient incentive to invest savings in improved means of production is seen in the development in the steel industry of the continuous hot and cold strip rolling mill, which revolutionised previous production methods, and by making a better product at lower cost opened the door to many new uses for hot and cold rolled strip. The result was that the annual production of cold-rolled strip and tinplate increased substantially between 1929 and 1939. It opened new employment opportunities in the steel mills, in industries using the new material, and in the plants of machinery manufacturers and allied lines who manufactured all the new equipment required by the steel mills and by the users of strip and tinplate. Such new developments as this are typical examples of the contribution of private enterprise to employment, but it should be noted they are not in themselves an agency for creating employment independently of the incentive to develop them created by the profit motive.

It also furnishes an illustration of the *rôle* of the industrial equipment industries in relation to employment. Their *rôle* is not just to use their productive capacity to produce articles made of iron, steel, and other materials, for which they have foundry and machine shop facilities, but to use their technical experience and ability to create new machinery and processes capable of producing so much more than existing machines and processes, that it is profitable to throw away the old ones and to invest accumulated savings in the new. They must endeavour to make obsolete as soon as possible everything they now have to sell. The development of such new machinery and processes requires not only technical experiences and ability, but money saved out of their current production, and the risks involved in putting money into development of this kind are considerable. It is only worth while if the equipment industries are permitted to retain a sufficient part of the gains to compensate them for their risk. They are an important factor in stimulating employment, but to carry out this *rôle* they must be strong both technically and financially. These industries more than all others, and all their employees who have acquired the highly specialised knowledge necessary to operate them, depend for their existence upon a continuous accumulation of savings from current production, and their conversion each year into improved means of production.

* * *

Considering the degree of sub-normal employment in the construction and industrial equipment industries in the United States and Canada during the period of 1933 to 1939, it is obvious that there were not enough people willing to convert their savings into new capital investments at that time. Evidently they considered the gains were not equal to the risks involved. Either the risks were too great or the gains were too small, or both. This was the position in 1929, when the stock market broke. It was still the position in 1939, although the reasons were not the same. That is to say, in 1929 capital values were too high in relation to the probable earnings. In 1939 the probable earnings were too low in relation to capital values. The situation in 1929 was the result of uncontrolled free markets. The situation in 1939 was the result of public policies adopted with a view to remedying and preventing a repetition of the conditions of 1929. But the effect upon employment of both these situations was the same. Undoubtedly governmental control in some form, most probably in the direction of a wisely applied taxation at the right time, is desirable to prevent a repetition of the conditions of 1929, but it is also necessary that suitable counter measures should be taken to prevent a repetition of the unsatisfactory employment conditions which prevailed between 1933 and 1939.

There were two major items of public policy which affected both earnings and capital values between 1933 and 1939. They were: (1) labour policy and (2) taxation.

It was public policy to maintain wage rates and even to increase them and to limit the hours of employment on the theory that this would give employment to more people and maintain purchasing power. There was an Arbitration Board in New York which awarded a Bricklayers' Union an increase in wage rates from 1·55 dollars per hour to 1·70 dollars per hour because the union was able to demonstrate that their members had not earned more than 800 dollars a year at the lower hourly rate! Unfortunately, there are not enough people who know what an intimate relationship there is between wage rates and savings and investment and therefore employment. They do not understand that annual income can be larger with a lower hourly rate of wages. You can fix a wage rate by legislation or by agreement, but it will not guarantee anyone an income. It is axiomatic of all trade that if you cannot trade at one price you must trade at another. But above all there must be trade or income stops.

It must be more widely understood that wage rates as well as prices, however established, which are either too low or too high, interfere with trade and therefore with production and employment. Minimum standards, of course, are necessary to preserve the health and *morale* of the people; but except for these safeguards, wages and prices must be free to find their own proper balance through agreement between employer and employee, on the one hand, and between buyer and seller, on the other, in order to assure that the maximum volume of production shall continue.

One cannot fail to note that public policy during the depression years was to tax and borrow (borrowing is only deferred taxation) to pay for unemployment and to prime the pump with public spending in an endeavour to create employment. This caused not only an immediate reduction in the net returns from savings invested in private enterprise, but, worst of all, the fear of higher taxation in the future, resulting from a continuation of such policies, created an additional risk to the investor, added to the normal commercial risks involved in investing money for business purposes. The record clearly shows that the effect was to restrict severely throughout this whole period the investment of savings in new building construction and in improved industrial equipment, and therefore to restrict correspondingly employment opportunities in these industries and indirectly in others.

* * *

Consider for a moment the effect upon business if our present rates of taxes are continued when the war is over. No [Canadian] company can now earn more than 70 per cent. of its standard profits during the base period 1936 to 1939. There is no investment of its savings which it can make to improve its products or to improve its own manufacturing facilities which can increase its earnings by one dollar. (The refundable portion of the income tax offers some indirect incentive to operating economies, but is not sufficient to justify investment in new equipment.) A continuation of present taxation rates in peacetime would inevitably result in the stagnation of individual initiative and private enterprise. It is only a matter of degree between what these conditions would be and those of 1939. The record shows that 1939 was far from satisfactory from an employment point of view.

It is not a fair appraisal of the facts (1929–39) to say that the system of private enterprise had failed. The failure was caused, to a very large extent, by our own careless handling of our business affairs. For instance, it was generally accepted as a matter of public policy all over this continent to increase Government spending to support the unemployed and to stimulate employment. It was also public policy to obtain the money to meet the Government's requirements by levying increased taxation in accordance with the taxpayer's ability to meet the payments rather than with any consideration to the effects of such taxation upon employment. It was this public policy which, no doubt unwittingly, produced conditions unfavourable to the expansion of enterprise and employment.

* * *

Corporate enterprises and governments are not expected to gamble with other people's money, but the difficult transition from a total war economy to a peacetime economy cannot be carried out by permitting the situation to

develop of its own accord without incurring risks far greater than would be run by adopting a positive policy of action. The situation must be faced with the same determination and confidence as that shown by some of our industrial pioneers. Andrew Carnegie built his steel empire when his existing steel plants were the least occupied with work. By doing so he borrowed money at the cheapest rate and bought his labour and materials at the cheapest price. But of more importance, he supported employment when it was most needed. It takes courage and confidence in the future to build more plants when you cannot employ the ones you have. It requires not only confidence in the conditions of this year or next. Capital investments are made for the future. The assurance of a continuation of sound fiscal policies and steady exchange values over a reasonable period of years is one of the first and most important considerations.

Private enterprise must prepare its plans for the post-war expansion of enterprise and employment on the confident assumption that if it is ready to assume the task when the war comes to an end, we will have a Government which will be ready to produce conditions favourable to such expansion. Enterprise will not be ready to assume the task unless its plans are complete and ready to put into instant operation *before* the war comes to an end. We all know how long it has taken to plan and equip ourselves for war. It will take as long, and perhaps longer, to plan and equip ourselves for full employment in the production of peacetime goods. We did not know that war would come in 1939, so we did not plan for war, but we do know that peace will come within the foreseeable future and that we must be ready to deal with it.

Once full employment has been attained it will be of equal importance to keep it in that condition. In a completely unrestrained system of private enterprise its defects from the employment point of view are that the right of the individual to use his income as he pleases carries it from excessive activity to excessive inactivity. These defects can be counteracted more effectively by sound Government policies which will influence the initiative of the individual than by measures which, either through direct compulsion or taxation, transfer decisions from the individual to a Government office.

* * *

These observations may be summed up by saying that our post-war aim of full employment and a rising standard of living is a problem primarily of achieving and maintaining the maximum volume of production, not only of consumer goods, including consumer durable goods, but along with it the maximum production of capital goods in the shape of new construction and improved means of production and distribution. Unlike consumer goods and consumer durable goods, the benefit to the consumer of capital goods is only indirect, so that some other stimulus is needed to make it worth his while to put a part of his income into capital goods. During the war all the money required to support maximum production and employment is provided by taxation and borrowing under the stimulus of the current will to win the war. When the war is over another stimulus will be needed. This stimulus must be provided by fiscal and economic policies which will encourage thrift and the conversion of savings into capital investment through private enterprise and which will give those who save and invest the assurance of stability in the exchange value of their savings over a reasonable period of years. The test of every fiscal and economic measure must be its effect upon overall production and employment. No real or lasting security can ever be achieved merely by a redistribution of the national income, which is all that the Beveridge plan or any similar social security plan can do. Every such plan must have as its foundation sound fiscal and economic policies which will assure, at all times, conditions favourable to the expansion of enterprise and employment. Without this the financial requirements of any such plan will depress employment and therefore cannot be supported and will fail in its purpose. And lastly, but not least important, we must prepare our post-war plans and policies *now* so that there will be no planning or waiting period after this war, as there was at the end of the First World War and at the beginning of this.

Erection of a Standard Unit Bridge

IN our issue of May 30th, 1941, we published general particulars of the standard unit system of bridge construction developed by the Butterley Company, Ltd., Derby. We now give particulars of the erection of one such bridge having a total span of 270ft., which was urgently required across a British waterway. The bridge consists of three spans of 90ft. single-girder, single-tier construction, to carry lorries up to 14 tons weight. The time taken in erection after materials were delivered and the abutments and piers were in position was only 120 hours. Only nine men and two boys were employed on the work.

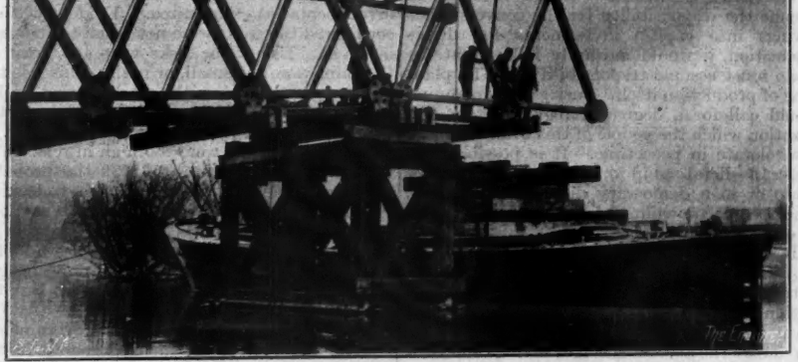
The Butterley standard unit system is designed for the rapid erection of permanent or temporary bridges, using five standardised parts only. These parts comprise :—(1) Welded box girder for all chord and diagonal members ; (2) connecting bobbin for intersection points ; (3) cross girder suspension plate ; (4) cross girder unit ; and (5) floor plate. The essential feature of the design is the use of these five members in different constructions to form all types of bridge from a light footbridge to a heavy bridge of 150ft. single span. All parts are easily handled with light appliances, and there is no riveting to be done, either in the production stages or on site. The design includes details which assist in erection and the attachment of the tackle, davits, &c., used in assembly.

Two concrete abutments were made and then two piers were driven and erected, each pier consisting of six 14in. by 14in. timber piles suitably braced and provided with steel channel supports fixed at the top to receive the steel superstructure. The road access to the bridge was from one side of the river only, so that one half of the superstructure material had to be transported across the river.

The approach spans have a gradient of 1 in 11·25 to allow 12ft. clear head room under the centre span to permit river traffic to pass below. As the working space on shore was only 20ft., the launching of the completed spans in the normal way was not practicable. It was therefore necessary to build a portion of the bridge on shore, and as the erection proceeded, the pier end was placed on a barge, and, as additional units were erected at the shore end, the barge and steelwork were moved out into the stream nearer to the pier, until 90ft. of the bridge was completed and lowered on to the abutments and piers.

COMPLETED APPROACH SPAN

The 90ft. centre span was cantilevered out in halves from the approach spans, and the halves were joined at mid centre. Temporary ties with screw adjustment were attached to the top chord over the piers to support each cantilevered portion during erection. Fine adjustment of these screws made possible the joining of the halves of the centre span by means of standard pins. When the centre span had been joined, the temporary ties on the top chords were removed, thus making each span independent. Expansion is accommodated on the piers by machined steel bars, which allow one end of each span to slide as required.



CANTILEVERING OUT CENTRE SPAN

The weight of the steelwork in each span of 90ft. is 30 tons, and the manufacturing time at the works for all the steelwork of the bridge

was only three weeks. The employment of welded construction enabled the parts to be fabricated with ease and rapidity at low cost. The standard of interchangeability was such that the pins at all intersections were immediately inserted, including the pins for the final joining. The bare minimum of material was brought to the site, and when the men had finished, the bridge was at once put into use. There was no clearing up required and no tackle other than the standard davits, spanners, &c., was used. These davits are a feature of the design, and are so made as to be attached in cups and sockets to each bay as the work progresses, thereby greatly simplifying the positioning of the various units as erection proceeds.

COMPLETED BRIDGE

The Butterley system permits the side structure to be built up either as a construction employing a single row of box girders, as in the bridge described, or in a double or triple row of box girders at each side of the bridge, the extra box girders being erected alongside the original box girder at each side and secured by tie bars and distance pieces through the centre holes in the connecting bobbins. Heavy type bridges of long span can be of double-tier construction below or above the main tier. A bridge similar to that described, of 60ft. span of single-girder construction, is in use as a single-track railway bridge.

DECK OF BRIDGE

Hand Feed Surface Grinding Machine

A NEW hand-operated surface grinder has been introduced by E. H. Jones (Machine Tools), Ltd., Edgware Road, The Hyde, London, N.W.9. It is especially suitable for tool room or production work.

The spindle is driven from a 2 H.P. motor, and three spindle speeds are obtainable through vee belts. The motor is mounted on a plate within the base of the machine and has adjustment for belt tensioning. Special flexible packing between the motor and base plate eliminates vibration. The motor and long vertical driving belt are easily accessible through a hinged door at the back of the column.

The table is traversed by rack and spiral pinion, and is guided on the saddle by vee and flat ways. Spring-loaded stops are fitted to it to prevent shock at the end of each traverse. The cross traverse screw is of acme form, and a micrometer dial graduated 0·002in. is fitted. The table is raised and lowered through bevel gears by means of a vertical acme thread screw graduated to 0·001in. These graduations are spaced ¼in. apart and for setting purposes the position of the zero pointer can be adjusted by means of a conveniently placed thumb screw.

HAND FEED SURFACE GRINDER

The standard machine is suitable for dry grinding, but a wet grinding attachment can be supplied as additional equipment. This attachment consists of splash guard for the table and a separate coolant tank incorporating an electric suds pump. A diamond holder which can be fitted to the table or to a magnetic chuck is provided for wheel dressing.

The working surface of the table measures 6in. by 18in., and the longitudinal, transverse, and vertical travels of the table are 19½in., 7½in., and 11in. respectively. The capacity under the 10in. grinding wheel is 10in.

Sixty Years Ago

BRITAIN'S FOOD SUPPLY IN WARTIME

IT is interesting to read a leading article, entitled "Our Food Supply in War," in our issue of July 27th, 1883, and to note how the prognostications therein made compare with the actual experiences of the country during the two great wars which have occurred since that date. In those days France was the potential enemy in our minds. It was recognised even then that we produced insufficient food for our needs and that if our overseas supplies were stopped the country "would be as surely starved out as was Paris in the winter of 1870–1871." We knew, it was stated, that the policy which commended itself to foreign naval authorities—notably those of Russia—was, in the event of war with this country, to avoid our men-of-war and to strike at our merchant fleet. It was certain that the French Navy, approaching our own in the number of first-class ironclads, would find a magnificent prey in our mercantile shipping, which consisted of over 17,000 sailing ships and nearly 3000 steamers. These ships, we said, would have to run the gauntlet through water infested with the enemy's cruisers during the first three months of war. Convoys would be run under the protection of some of our slower ironclads, and some of our faster merchantmen would doubtlessly be armed to a degree that would enable them to deal with any enemy cruiser sufficiently swift to overhaul them. Nevertheless, we concluded pessimistically, the complete or partial failure of our supplies in wartime could be regarded as being unavoidable. One unknown quantity would be the part played by the fast gun and torpedo ship.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

FLEXIBLE TRAILING CABLES FOR QUARRIES AND METALLIFEROUS MINES

No. 1116—1943. This new specification is intended to cover the requirements relating to flexible cables contained in various Statutory Rules and Orders. The specification does not include collectively screened cables, which are provided for in B.S. 708, but such collectively screened cables are not recommended for use in open-cast workings or in any other conditions where the cable is exposed to the elements. The new specification provides for pliable armoured cables, both three-core and four-core up to 660 volts, and four-core up to 3300 volts. Individually screened cables, both three-core and four-core, up to 660 volts, are also included.

DIAMOND-TIPPED BORING TOOLS

No. 1120—1943. This War Emergency Specification was prepared by co-operation between the Institution and the Tool Technical Panel of the Ministry of Supply Diamond Die and Tool Control. It is primarily a dimensional standard and prescribes the dimensions for seven sizes of boring tools suitable for boring holes ¼in. diameter upwards. Each diameter tool is standardised in a variety of lengths to permit of alternative methods of mounting in the boring bar. A code system is given, to facilitate ordering the tools according to their standard diameters and lengths. Full details are given for the cutting angles and the position of the diamond relatively to the axis of the tool. Some notes, prepared by the Tool Technical Panel of the Diamond Die and Tool Control, are included, to give guidance in regard to such matters as the smooth running of machine spindles, the foundations and mounting of machines, and the setting of the tools. Price 1s. post free.

BOILER RIVETS

Revision of No. 425—1943. This British Standard was first issued in 1931 and the present edition has been prepared in order to incorporate an additional form of head, namely, a pan-head rivet with a conical neck, used in water-tube boiler construction. Price 2s. post free.

The Spectrographic Analysis of Cast Iron*

By E. B. LING, J. McPHEAT, and J. ARNOTT, F.I.C.

THE industrial spectrograph finds its greatest application in the routine analysis of steels, aluminium alloys, and brasses. The equipment at Cathcart was not purchased primarily for any one of these uses, but as a general-purpose tool, with the expectation that it would serve for some difficult estimations in nickel alloys. It might be added that several of the latter have since been handled with satisfactory results. Shortly after the spectrograph was installed, it was considered that it would help to build up

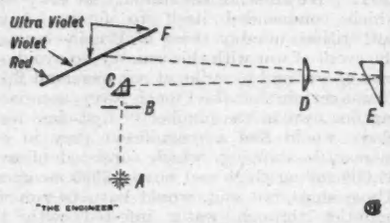


FIG. 1—*Large Quartz Spectrograph Optical Train*

general experience if the method could be used for a period on samples which were being analysed daily by chemical means. At the time the most readily available were cast irons.

The most of the work was done some considerable time ago, but the original programme was not completed because some more immediately urgent work had to be undertaken. In recent months several firms have become interested in the subject, and since little work on cast iron appears to have been done, or at any rate published, in this country, the authors felt that it might be of some small service to give the results obtained, even though the range of alloying elements is rather narrow.

GENERAL DESCRIPTION

It is probable that the whole matter may be new to some of the members. Hence it might be useful to give a very brief description of the apparatus and the method of use.

The industrial spectrograph covers a wave band of 2000 Å to 8000 Å.† Alloys of the ferrous group give a spectrum containing so many lines that maximum dispersion is essential. Hence the largest size instrument is necessary. The work to be described was done on a large-size Hilger quartz spectrograph. In this instrument the band of 2000 Å to 8000 Å would give a spectrum of 30in. long. A photographic plate of this length is impracticable, and the instrument is therefore so designed that the complete spectrum can be photographed in three sections of 10in. Any 10in. of the 30in. can be utilised. Throughout this investigation a band of 2700 Å to 4300 Å was used.

The essential features of the spectrograph itself are shown in Fig. 1. The light from the sample A is passed through the slit B and is reflected by the right-angled prism C to the collimating lens D. It is then reflected by a 30 deg. Littrow prism E. The back of this prism is a mirror which reflects the light back through the collimator. The latter now acts as a camera lens to the photographic plate F. It will be readily understood that since the work is in the ultra-violet region the lenses and prisms must be made of quartz.

Slit Width.—The function of the slit is to control the width of the lines which appear on the spectra. In the authors' work a slit of fixed width, 0·015 mm., is employed.

Excitation.—The light is produced by a high-tension discharge between the sample and a graphite electrode.

Plate.—The plate used is 10in. by 4in., and the type of emulsion is not widely different from that used in ordinary photography. Many spectra can be taken on one plate, because they need only be a few millimetres in height. In the work to be described, a slit height of 2·5 mm. was employed throughout. This allows up to twenty-four separate exposures to be taken on one plate.

OPERATION OF SPECTROGRAPH

The manipluative side of the whole method is best shown by the three photographs in Figs. 2, 3, and 4. Fig. 2 shows the exposure of the plate. The spark seen at the right-hand side is being produced by a high-tension discharge between the sample which is below and the graphite electrode above. Fig. 3 indicates how the visual comparison and recognition of the line is made in the "Judd-Lewis" comparator. In this instrument any plate can be easily compared with a standard plate bearing spectra from alloys containing all the elements under consideration, or even from composites of the various pure metals or ferro-alloys in the powdered state. The standard plate is not used quantitatively; it is only utilised to spot the important lines of the elements. Fig. 4 illustrates the measurement of line intensities in the micro-photometer.

The spectrograph requires solid specimens (not borings), and these may be of any reasonable size and shape, but preferably about 1 cubic inch. A piece of 1·2in. diameter test bar is ideal.

QUANTITATIVE ESTIMATION

In very simple language, the mechanism of quantitative estimation by means of the spectrograph is as follows:—The spectrograph splits up composite light from the spark, giving series of lines on the photographic plate. Each element present gives lines of definite and known wave lengths. By reference to wave-length maps, it can be quickly determined if any one element is present.

It has been found by earlier workers that the percentage of any one element, say, manganese, in cast iron, is determinable by the internal comparison method. This is simply the measurement of the blackness of any one line of the element compared with that of a chosen line of the major element within the same spectrum. In cast iron the major element is, of course, iron. It may come as a surprise to some that most elements give many lines. Iron is profuse in this respect, giving something of the order of 10,000 lines within the range of this spectrograph.

FIG. 3—*"Judd-Lewis" Comparator*

The first step towards quantitative spectrographic analysis is the careful preparation and chemical analysis of a series of samples, say, six in number, covering the complete range of the element or elements to be determined spectrographically. The chemical analyses of these samples must be of the highest possible accuracy, since the value of the spectrographic estimation is completely dependent on this. A plate is exposed with the standards on it, probably in triplicate, and the intensities of the "line pairs" measured. This term is applied to the chosen lines of the minor and major elements. The ratio, or more generally the log ratio, of these intensities is plotted against the percentage of the element, and the curve so obtained is utilised for all future samples.

It will be appreciated that all factors connected with the exposure, the plate itself, and the details of development must be rigidly

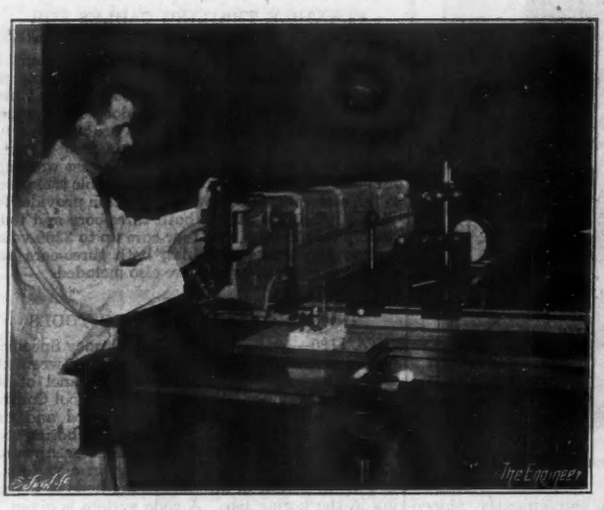


FIG. 2—*Exposure of Plate*

FIG. 4—*Microphotometer*

* The Institute of British Foundrymen, London, June 26th, 1943.

† Å = Ångström unit = 10^{-8} cm.

standardised. Many and possibly most of the discrepancies encountered are due to neglect to observe all the conditions and precautions.

Of the constituents present in cast iron, carbon, phosphorus, and sulphur cannot be estimated by the methods described in this paper. Silicon, nickel, manganese, chromium, and molybdenum have been estimated within certain ranges, and there is every reason to expect, from analogy with steel manipulation, that vanadium, titanium, aluminium, and traces of other accidental elements can be tackled.

Before going on to describe the experimental work, it should be mentioned that the authors took as their text-book throughout Mr. Barker's paper to the Iron and Steel Institute in 1939.

First Trials

No irons were available of compositions covering the range desired, and it was necessary to make up a suitable series. Details of the first set of standards to be prepared are given in Table I. These were all made in crucibles

TABLE I.—*First Set of Standards*

Mark.	Si, per cent.	Mn, per cent.	Ni, per cent.	Cr, per cent.	Mo, per cent.
2	1·00	0·51	—	—	—
4	0·68	0·31	0·28	0·21	0·37
5	1·28	0·62	0·43	0·42	0·38
6	1·51	0·79	0·73	0·51	0·70
7	1·68	1·01	1·10	1·05	1·04
8	1·90	1·14	1·13	1·14	1·18
9	2·32	1·30	1·45	1·06	1·37

from the same mixture by addition of the alloying elements. The total carbon, phosphorus, and sulphur were practically constant throughout at 3·3, 0·35, and 0·11 per cent. respectively.

The chemical figures were the mean of results from four analysts. The samples were cast in core sand, 1·2in. diameter, 6in. long, after discarding the head. Each sample was cut in half. One portion was drilled down the centre for its entire length and the drillings thoroughly mixed for analysis, the other half of each was reserved for the spectrograph.

The technique for the first set of trials was on the lines of that used for steels by the Admiralty laboratory in Glasgow University. The conditions were as follows :—

Wave band	2700–4300 Å.
Slit width	0·015 mm. (fixed slit)
Spark gap	3 mm.
Voltage	15,000 volts
Added inductance	Nil
Upper electrode ...	H.S. graphite pointed to 80 deg. angle
Lower electrode ...	Sample, filed flat on sparking face
Exposure	90 sec., made up of six separate exposures of 15 sec. across face of sample, top electrode changed after three exposures
Plate	Ilford thin film half-tone
Development... ...	(a) 90 sec. at 19·5 deg. Cent., using 100 cc. standardised developer (b) Fixed in acid hypo. for 7 min. (c) Washed, running water, for 15 min. (d) Dried, warm air from hair drier

This gave somewhat under-exposed plates, which were not suitable for measurement. The next set were run with :—

Exposure	2 min., made up of four separate exposures of 30 sec. each; graphite electrode changed every 30 sec. exposure
Development... ...	2½ min. in 100 cc. standardised developer at 19·5 deg. Cent.

All the other conditions were similar to the first. The standard samples were exposed in duplicate (plate *f*.21), and from this plate a set of curves was prepared, using the following line pairs :—

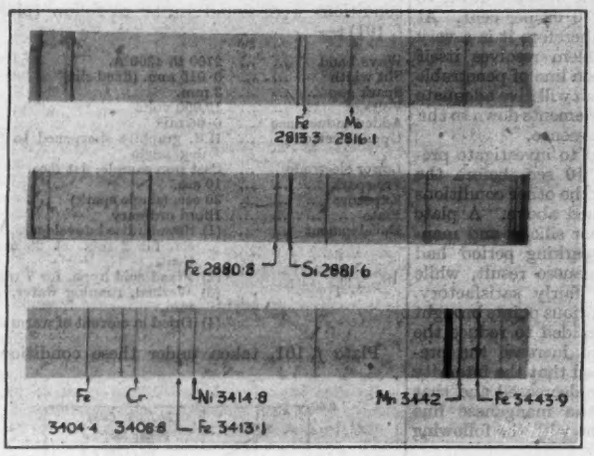


FIG. 5—*Line Pairs for Alloy Cast Iron*

Silicon	2881·6 Å. with iron 2880·8 Å.
Manganese ...	3442·0 Å. with iron 3443·9 Å.
Nickel	3414·8 Å. with iron 3413·1 Å.
Chromium ...	3408·8 Å. with iron 3404·4 Å.
Molybdenum ...	2816·1 Å. with iron 2813·3 Å.

The significance of line pairs can be better appreciated by reference to Fig. 5, which is a series of enlargements of portions of an alloy cast iron spectrum. The curves are reproduced in Fig. 6. These curves were mainly good, and they were used for a period to check routine samples which were analysed chemically. Over this period agreement was tolerable, but a few excentric figures for manganese called for further work.

TABLE II.—*Second Set of Standards*

Mark.	Si, per cent.	Mn, per cent.	Ni, per cent.
A.1	0·95	0·48	1·72
A.2	1·15	0·69	1·03
A.3	1·37	0·81	1·13
A.4	1·65	0·94	0·60
A.5	1·94	1·03	0·30

At this stage the original batch of plates was exhausted. New curves were drawn for the next batch of the same type, and it was found that the new curves were so similar to the original that no serious error would have been caused by using the old curves for the new plates.

Second Set of Standards

After some further work, it was realised that the composition of the first series of standards had not been well chosen. Some were difficult to drill for chemical analysis, and, furthermore, the progressive increase in all the added elements resulted in considerable differences in the iron content. These, it was thought, might affect the density of the lines of the major element. It was resolved to make a new series and to limit the range to that required for the routine examination of samples as then received from the foundry. Details of the second set of standard samples prepared are given in Table II.

In the second set of standards, Cr and Mo were not included, because iron with these elements was seldom received in the laboratory, and also because the original curves from plate *f*.21 were so satisfactory that new curves could be readily made at any time, using the same line pairs, if the need arose.

At this time Zenith H. & D. 700 plates were being used for arc spectra of non-ferrous alloys, and since the number of routine cast iron samples was small, it was decided to see if a compromise could be effected to save plates and processing time. Ilford ordinary plates were chosen, and this choice was endorsed by work done by Hilger, Ltd., on some samples of cast iron which had been sent for manganese estimation. Hilger, Ltd., obtained very good results, using Ilford ordinary plates. The conditions they used were :—

Wave band	2700–4300 Å.
Slit width	0·015 mm.
Spark gap	3 mm.
Voltage	15,000 volts
Added inductance	Nil
Upper electrode ...	H.S. graphite pointed 80 deg. angle
Lower electrode ...	Sample filed flat
Exposure	Single spark, 30 sec.
Plate	Ilford ordinary
Development	2 min. at 19·5 deg. Cent.

The standard samples were exposed in triplicate under these conditions. The plate was measured for silicon, manganese, and nickel, using the same line pairs as formerly. While the silicon and nickel curves were very promising, the manganese results were bad, and no

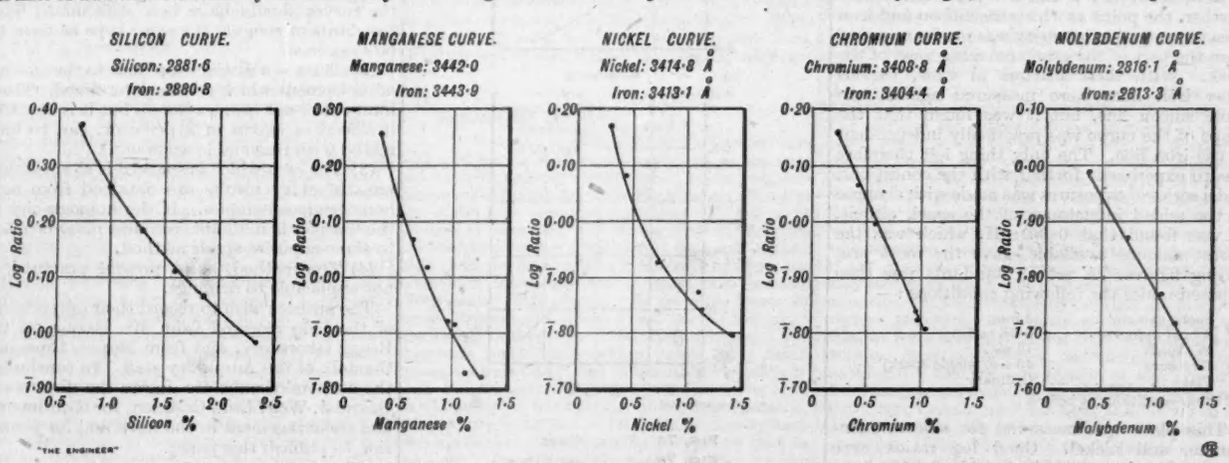


FIG. 6A—*Silicon Curve* FIG. 6B—*Manganese Curve* FIG. 6C—*Nickel Curve* FIG. 6D—*Chromium Curve* FIG. 6E—*Molybdenum Curve*

consistency could be observed. The silicon curve was used for checking some routine samples, but agreement was not very good. The difference amounted to as much as 0·10 per cent. silicon in samples containing about 1·5 per cent.

From the outset it had been recognised that the silicon estimation was one which would present the greatest difficulty. Unfortunately, silicon has only one line (2·881 Å) in the portion of the spectrum generally used for iron and steel analyses. This line is so strong that it is used for the estimation of silicon in steel down to percentages of the order of 0·02 per cent. At figures of 1 to 3 per cent. therefore it is a very intense line, and the problem resolves itself into one of obtaining a silicon line of penetrable density, with exposures which will give adequate density in the lines of other elements down to the low limit of their possible presence.

After this, it was decided to investigate pre-sparking for a period of 10 sec. before the exposure of 30 sec., with all the other conditions the same as those mentioned above. A plate was taken and measured for silicon and manganese (*f.* 81). The pre-sparking period had clearly benefited the manganese result, while the silicon line was also fairly satisfactory. After consideration of the various points brought out by this trial, it was decided to reduce the exposure time and also to increase the pre-sparking time. It was hoped that the intensity of the silicon line would be decreased and that further improvement in the manganese line might result. This was done with the following altered conditions :—

Pre-spark	15 sec.
Exposure	25 sec. (single spark)
Plate	Ordinary

All other conditions as before.

This plate gave promising results for silicon, manganese, and nickel. The manganese showed increased reproducibility. After consideration of the graphs, it was thought that the one for silicon might be improved by trying some other iron line for comparison. This silicon graph showed an almost straight line between 1·0 and 1·4 per cent. silicon. Thereafter it developed a curve between 1·4 and 2·0 per cent. silicon. Further, the point at which the silicon and iron lines were equal in intensity was too far removed from the part of the graph covering most of the work. With these matters in view, various other iron lines were measured against the usual silicon line, but it was found that the shape of the curve was practically independent of the iron line. The only thing left therefore was to experiment further with the conditions, and a series of exposures was made with changes in the added inductance of the spark circuit. It was found that 0·06 mH, which was the lowest amount available, gave the most promising figures. A set of standards was then exposed under the following conditions :—

Spark gap	3 mm.
Added inductance ...	0·06 mH
Pre-spark	10 sec.
Exposure	40 sec. (single spark)
Plate	Ordinary

All other conditions as before.

This plate was measured for silicon, manganese, and nickel. Good log ratios were obtained, agreement being within 0·010 of the average. The graphs prepared from this plate gave smooth curves. The silicon curve was used to check routine samples over a short period.

When the results were reviewed, it was found that roughly 40 per cent. showed a disagreement between chemical and spectro of over 4 per cent., and it seemed probable that there had been some want of care in some of the smaller details. On investigation of the alignment of the light source, it was established that errors up to ±0·08 per cent. silicon were possible through incorrect alignment of the electrodes in both the horizontal and vertical planes.

The other sources of error were connected with the temperature and quantity of developer. It was found that the volume of developer had an effect on the density of the plate. Hence any accidental spilling would alter the density. This effect was lessened by increasing the volume of developer used.

It was realised that insufficient attention had been paid to temperature. The dark room temperature was frequently higher than 20 deg. Cent., and a rise of 1 deg. Cent. of the developer was possible during the time of development. From this investigation it was decided to standardise development in future to 150 c.c. developer and 20 deg. Cent., using a thermometer reading to 0·1 deg. Cent.

Final Conditions

As a result of many experiments, the best conditions were found to be as follow (plate *f.* 101) :—

Wave band	2700 to 4300 Å.
Slit width	0·015 mm. (fixed slit)
Spark gap	3 mm.
Voltage	15,000 volts
Added inductance ...	0·06 mH
Upper electrode ...	H.S. graphite sharpened to 80 deg. angle
Lower electrode ...	Cast iron sample, flat face
Pre-spark	10 sec.
Exposure	30 sec. (single spark)
Plate	Ilford ordinary
Development	(1) Standardised developer, 150 c.c. for 2 min. at 20 deg. Cent. (2) Fixed acid hypo. for 7 min. (3) Washed, running water, 15 min. (4) Dried in current of warm air

Plate *f.* 101, taken under these conditions,

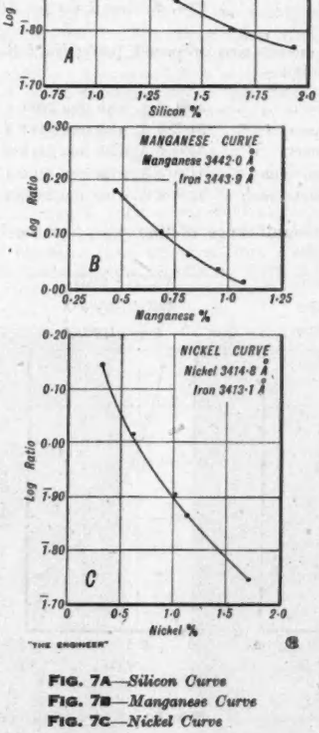


FIG. 7A—*Silicon Curve*
FIG. 7B—*Manganese Curve*
FIG. 7C—*Nickel Curve*

gave the curves illustrated in Fig. 7. The curves were all satisfactory and in later work no further change in conditions was found necessary. Subsequent exposures of routine samples and the standards under these conditions gave results which agreed within the usual analytical tolerance with the chemical figures.

Assessment of Utility

The place of spectrographic work in cast iron analyses must in all cases be affected by the type of iron to be tested, the number of samples to be handled, the need or otherwise for speed, and the specific alloying elements to be estimated.

When this investigation was commenced, spectrographic analysis was the only alternative to purely chemical methods. Since then, however, the Spekker absorptiometer has come into prominence, and it undoubtedly provides excellent methods for the estimation of elements which directly or indirectly give coloured solutions. The estimation of manganese, for example, is delightfully speedy and accurate. It can be safely assumed that both spectrographic and absorptiometric methods will be intensely developed in the near future, and any attempt at appraisal of their relative suitability can only be taken as applying to to-day's date.

Advantages and Limitations of Spectrographic Analysis

The advantages of spectrographic methods as applied to cast iron might be stated as :—

(1) *Speed and Reduction of Labour.*—Once the conditions are established, routine samples can be run through quickly, taking spectrograms of, say, a dozen samples in duplicate on each plate. Each sample may contain five elements which are to be estimated. The preparation, exposure, development, &c., are the same, no matter how many elements are to be estimated. The only difference is the few additional minutes at the microphotometer.

As a rough idea of the overall time involved, a single operator averaged 2½ hours for nine samples of cast iron. In these, silicon, manganese, and nickel were estimated in duplicate. This gives a time for each duplicate estimation of under 6 min. This was done without any attempt to cut the time to the minimum, and the allocations for some of the operations were very generous. With two operators, the time can be very much reduced. Apart from capital costs, the only outlay is that for plates and developer. With twelve samples on a plate, the cost per sample is under 2d.

(2) *Sample Easily Prepared.*—There is no need to drill ; hence the hardness of the sample does not matter.

(3) *A Permanent Record is Obtained.*—At any time a plate may be looked out and measured for some element not originally checked.

The disadvantages or limitations cover the following :—

(1) The method can only be applied to the estimation of elements whose log ratio curves have been determined. For maximum accuracy the curves should have been determined from standards of roughly the same type as those to be examined.

(2) There is a distinct top limit to the amount of an element which can be determined. These limits have not been explored, but it is doubtful if silicon in excess of 3 per cent. can be estimated with reasonable accuracy.

(3) The area which is sparked is so small that unsatisfactory results are obtained from non-homogeneous samples. If the homogeneity of the samples is in doubt, recourse must be made to the composite spark method.

(4) The method, as at present practised, is not applicable to drillings.

The authors wish to record their appreciation of the help received from Mr. Barker, of the Bragg laboratory, and from Messrs. Cross and Goodall, of the Admiralty staff. In conclusion, the authors' thanks are due to the directors of G. and J. Weir, Ltd., Cathcart, for their interest and encouragement in the work and for permission to publish this paper.

Additions to the Swedish Navy.—In the early days of June the Swedish Navy received delivery of another submarine of the "coastal" class of about 400 tons. Previously, three submarines of this type, which is entirely new in the Swedish Navy, had been delivered. About the same time the Swedish Admiralty announced the delivery of the "Visby," a destroyer of the "City" class, but of an enlarged and improved type. While earlier destroyers of that class have had a displacement of about 1100 tons, the "Visby" and a number of sister vessels, which are under construction, are of about 1200–1300 tons. In addition, the armament, which consists of three 12-cm. guns, has been placed somewhat differently compared with the earlier vessels, and the number of anti-aircraft guns has been considerably increased. Another novelty in the new series of improved "City" destroyers is that the ships have been provided with a square or cut-away stern, instead of cruiser stern, whereby the speed, which officially is 39 knots, has been increased.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

A World Trade Alliance

Initial moves have been made in the establishment of a World Trade Alliance. The author of the scheme is Sir Edgar Jones, widely known as the Tinplate Trade Administrator, an office created by the tinplate manufacturers some years ago. The scheme provides for the creation of an international organisation maintained by a World Trade Alliance Council established by Governments to regulate international trade. The executive agencies of the World Trade Alliance Council include a series of world Export Product Committees, a Central World Clearing Bureau, a Central World Development Commission, and a Central World Debt and Money Commission. The Council will arrange for representatives of exporting countries and of consuming interests to constitute a product committee for each main export product. The committee will work out the terms and conditions of an international agreement for a quantitative distribution of exports and for maintaining reasonable economic export prices stabilised for a period of years. The Committee will supervise the operation of the agreement, regulate the export trade in the product, and co-operate with the World Development Commission so that there may be a sufficient expansion of world consumption to ensure a complete distribution of the agreed export quotas. The operations of the product committees will be determined by the general policy of the Governments; the aim will be the complete distribution of the product and expansion of consumption. The Central World Clearing Bureau will assist the various product committees and endeavour to get other countries to balance their total imports and exports by the exchange of products of employment for products of employment. The Central World Development Commission will be a permanent body composed of engineers, administrators, and other experts to deal with projects of relief and development in distressed or depressed countries of sufficient magnitude to enable the product committees to achieve a complete distribution of their exports so that stocks shall not accumulate. A development fund may be provided by a premium on all export bills. A Central World Debt and Money Commission will deal with the money or financial affairs between countries.

The Pig Iron Market

Large quantities of pig iron of all descriptions are passing into consumption, and production is maintained at a high rate. The demand is chiefly noticeable for special sorts of foundry pig iron, medium-phosphoric, special refined pig iron, and hematite. These are the pig irons in which there is some evidence of stringency in supplies, particularly in the case of hematite. The principal consumers are the engineering and jobbing foundries, which are busily engaged upon Governemnt orders and are turning out castings for a wide range of armaments, aircraft, and machine tools. The demand seems to be steadily increasing, and the pressure upon the producers shows no sign of relaxing. The production of hematite and low and medium-phosphoric iron should shortly show an increase as the producers receive supplies of high-grade ore from North Africa. The stringency in the supply position of these irons is well understood by consumers, and wherever possible they use substitutes, and the Control shows great care in allocating pig iron of these descriptions to consumers. On the whole, supplies are well maintained to users employed upon urgent work. The production of high-phosphoric pig iron is on a considerable scale, and consumers find no difficulty in covering their requirements. In normal times the demand for this iron arises principally from the light castings industry, but, since the war, these foundries have been only poorly employed, although the situation has improved in recent months, as some of them have found employment in producing castings for the engineering industry. In the majority of cases, however, it has not been found possible to utilise the services of the light castings foundries in the war effort, but where possible plant has been adapted to this purpose. The raw materials position, excepting in the case of high-grade ore, which is improving, is satisfactory. The furnaces find that they can obtain their full requirements of foundry coke, and deliveries are being received regularly. Those foundries which have the requisite accommodation are seeking to build up reserves, but a larger number of foundries rely upon regular short-period deliveries of their supplies of coke. An important volume of business is being transacted in basic pig iron. The steel works, however, are receiving full supplies, and the requirements of consumers of forge iron are being adequately met.

The Midlands and South Wales

There has been no decline in the pressure of demand for all the main products of the Midland iron and steel works. A large proportion of the demand is for steel materials required by firms engaged on war work. To some extent the requirements of the armament makers have changed, and there has been a noticeable decline in the pressure to obtain shell steel. Production for some time has been at a very high level, and users have been able to build up stocks. This has enabled the Control to divert plant engaged on shell steel to other materials. Generally, however, when it has been possible to relax the production of some classes of steel, an increased demand makes itself felt for other types. For instance, the steel required for aircraft production, especially alloy steel, seems to be in heavier request, and, in spite of the recent improvement in the output of special steels, the demand is practically abreast of the supply again. There is still a strong request for ferro-chrome, ferro-silicon, and those alloys used in the manufacture of the commoner grades of alloy steel. On the other hand, the demand for alloys used in the more expensive descriptions has declined, although the impression prevails that this is only a temporary movement in the market. An outstanding demand continues for ship plates and boiler plates, which are being produced in heavy quantities. Despite the high production, however, delivery dates tend to lengthen under the pressure of the requirements of shipbuilders, tank makers, and heavy engineers. The re-rolling industry seems to be assured of full supplies of semis, and is operating practically at capacity. It is successfully meeting a strong demand for small bars and sections. The demand for heavy joists and sections is still on the quiet side and reasonably early delivery dates can be quoted for this class of material. Sheet makers are in the comfortable position of being assured of full employment on Government work for the next three months and can afford to be indifferent to the decline in the volume of new business coming forward. The iron and steel industry in South Wales is working under unrelaxed pressure. Large quantities of billets and other semi-finished steel are being produced, and, with stocks of imported material still available to be drawn upon if necessary, the consumers' position is satisfactory. There is a brisk demand for sheet and tinplate bars, although conditions in the tinplate industry are quiet.

Scotland and the North

It would be difficult to find a Scottish iron and steel works that is not operating at capacity and carrying sufficient orders on its books to ensure full operation until the end of September. Some of the works have accepted orders for delivery up to the end of the year. For a long time the Scottish steel works have been working to the limit of their plant, and the deliveries to firms engaged upon war production since the end of May have reached exceptionally high levels. As in other parts of Great Britain, the demand for plates has overshadowed business in other departments. The shipyards and ship-repairing yards have taken enormous quantities, and the tonnages passing to tank makers and locomotive builders have been on a large scale. Considering the enormous demand, it is not surprising that delivery dates recently have shown a tendency to lengthen more rapidly than in the past. The Control, however, is alive to the position, and is not likely to allow it to get out of hand. There is a considerable volume of business passing in small sections, which are required in large tonnages for various purposes in the country's war effort. Delivery of this class of material has lengthened considerably during recent weeks. The position of heavy joists and sections, however, is unchanged, and most of the producing works are in a position to accept more business in this class of material than is likely to come to hand. There is also a strong demand for bars of all sizes and the alloy steel makers are kept busily engaged. There has been some complaint recently in the Lancashire market that supplies of iron and steel scrap have become tight. With this exception, however, supplies of raw material are adequate. The demand for semi-finished steel is strong, but consumers are obtaining regular and sufficient supplies. There is a big inquiry in the market for small steel bars and sections, whilst consumers of alloy steel are pressing for deliveries. The demand for alloy steel, however, seems recently to have been concentrated upon the less expensive forms of this material. The steel works on the North-West Coast are working at capacity and are producing considerable tonnages of rails and semi-finished steel.

The North-East Coast and Yorkshire

The iron and steel industry on the North-East Coast is entering the third quarter with the certainty that busy conditions will rule until the end of the year. In some branches the pressure of demand appears to have lightened somewhat, and this is noticeable in the case of shell steel, but whatever relief has been experienced in one direction, it has been more than made up by an increasing pressure in others; for instance, in the demand for shipbuilding plates and other classes of steel needed in ship construction. The call for alloy steel, which recently showed slight indications of easing, has increased, and the strength of the demand is responsible for the efforts by the Control to conserve alloying elements by spreading the available quantities over a bigger tonnage of steel. It is claimed by the iron and steel industry on the North-East Coast that the production in that district during the past twelve months constitutes a record, although, of course, for security reasons no figures of production are allowed to be published. There has been a considerable increase in the output of billets, blooms, and sheet bars, which has greatly relieved the concern which was becoming apparent amongst re-rollers at the possibility of a tight position developing in semi-finished products. The pressure upon the plate mills shows no indication of becoming lighter. Large tonnages are passing to the shipyards, and it seems unlikely that there will be any relaxation while the war lasts. Shipyard requirements receive priority, but the producers have fully met the demand, and, in addition, have provided large tonnages for tank makers, boilermakers, and heavy engineers. A considerable tonnage of steel is also passing to the mining industry in the shape of rails, chairs, arches, and props. Conditions in the Yorkshire iron and steel industry have not materially changed, and although the steel works have been fully employed for a long period, there seems no indication that they can expect any respite whilst the war lasts. The call for alloy steel remains heavy, but the pressure appears to have become more pronounced in the case of the less expensive alloy steel. There is a particularly active request for alloy steel of grades required by engineers.

Non-ferrous Metals

Generally speaking, the supply position of non-ferrous metals is satisfactory, and the recent course of the war in the Mediterranean may enable the shipments to this country from Africa and Australia to be considerably increased, if necessary. The demand for copper for war purposes is on a heavy scale, but so far as can be seen all the firms engaged upon war work receive full supplies. Naturally the Non-ferrous Metal Control carefully watches the position and scrutinises the applications for licences. Where, however, the metal is required for essential purposes, no difficulty is experienced in obtaining it. Changes in the character of the armaments upon which production is concentrated naturally occur, and, at present, it would seem that the kind of armaments that are in chief request do not require copper in such large quantities as have been used in the past in their manufacture. Supplies, however, are understood to be reaching this country with regularity, and through the arrangements made by the British Government with Empire producers it has been possible to maintain unchanged the prices which were fixed in December, 1939. The world production of copper has, of course, reached a high level, but the question of shipping the material sometimes presents difficulties. . . . The main features of the tin position have not altered, and while great economy in the use of the metal is necessary, the war requirements of the Allies are being met. In all the countries to which the Allies have access the production of tin is being increased where possible. According to reports from the United States, the export of tin from the Belgian Congo this year is expected to be over 20,000 tons. . . . The opening of the Mediterranean to Allied shipping has led to expectations of increased supplies of lead. For some time, however, it is likely that the Non-ferrous Metal Control will have carefully to watch the position in this country, since the demand for war purposes is heavy. Consumers engaged upon war work, however, at no time have been kept short of the metal. . . . The spelter position, which for long has been regarded as the non-ferrous metal which was in most tight supply, is unchanged. The consumption of spelter by the war industries proceeds at a uniformly high level, and any relief which may be experienced by shortening the route from those overseas countries which provide Great Britain with spelter will be warmly welcomed by users. In the United States the position is fairly satisfactory.

Notes and Memoranda

Rail and Road

THE AMERICAN RUBBER SITUATION.—It is now reported that the productive capacity of all the synthetic rubber plants in the United States and Canada will be sufficient to meet military requirements by the end of 1943, but there is no hope, at present, that any synthetic rubber will be available for civilian use.

MOVING AN ESCALATOR.—Plans are under way to move one of the escalators on the Central London Tube. To meet the needs of traffic at the Bank Station, near the Mansion House, a second escalator is to be installed. It is proposed to transfer one of the three escalators from Chancery Lane Station, where a stairway will replace the escalator removed.

THE ALCAN HIGHWAY.—The spring thaw in Canada and the United States has been late this year, and what winter has done to the rather hastily constructed Alaska Highway has only now been fully disclosed. As was to be expected, much of the damage is due to washouts. Many timber bridges built by engineer regiments as temporary structures along the 1600-mile road have withstood the full force of river ice movements, and ferries are being used where bridges have buckled. Another bit of Alcan news is that a steel and cable suspension bridge, to cost more than a million dollars, is nearing completion. It will cross a river near Fort St. John, B.C., as a vital link in the Highway.

FEWER TRAINS: MORE PASSENGERS.—In 1942 passenger journeys on the L.M.S. amounted to 4300 million miles of travel, an increase of 50 per cent. over the year preceding the war. The figures are the more remarkable because, in order to make way for additional trains of war freight, passengers had fewer trains to travel by. Actually, the L.M.S. passenger train mileage last year was 31 million miles less than in the last pre-war year. An analysis shows that service travel accounts for 55 per cent. of all the journeys taken between 100 and 200 miles, and that for distances over 200 miles the amount of service travel is over 75 per cent. Workmen's travel increased by over 100 per cent. compared with pre-war.

RAILWAY WAGES.—In a Journal note of July 9th we made reference to the continued negotiations between the representatives of the Railway Executive Committee and the representatives of the Railway Shopmen's Union, concerning the claim of the union for an advance of 10s. a week, which affected about 100,000 railway shopmen. On Tuesday, July 20th, it was officially announced that the claim had been settled at a meeting of the Shopmen's National Council, which took place on Monday, July 19th. The shopmen, it is stated, are to receive a further advance of 4s. 6d. a week, which is in accordance with the advance awarded to the operative and clerical grades of railway workers. The advance will apply alike to time workers and piece workers and will date back to April 25th.

U.S.A. ARMY ENGINEERS IN NORTH AFRICA.—From America have come reports of the work Army engineers have done in North Africa, where they have built roads at a rate of 4 miles an hour. Especially organised pioneer road teams make the speedy construction possible. A powerful six-wheel-drive lorry carrying a tractor with a bulldozer runs ahead to attack difficult crossing points, such as steep-banked washouts. Elsewhere corps of amphibian engineers have learned, through the use of mesh foundations, to build beachheads for heavy lorries in from five to ten minutes. The Army engineers have many other highly specialised units which have accomplished other important tasks. They have purified water, supervised all camouflage installations, handled demolition projects, made maps, laid and cleared minefields, created obstacles, and constructed roads, bridges, and air bases.

Air and Water

AIRCRAFT ENGINE TESTING.—On page 505 of our issue of June 25th we published a note entitled "Breaking-in an Aero-engine," in which we referred to the development by the General Electric Company of America of an electric dynamometer, whereby the power developed by an aero-engine while being run in or tested could be fed to the mains or otherwise usefully employed. The English Electric Company, Ltd., Stafford, informs us that it, too, has been engaged with this problem, and has succeeded in evolving a satisfactory arrangement for the purpose, comprising a swinging frame D.C. dynamometer electrically connected to a D.C. motor, which is coupled to an A.C. generator on the Ward-Leonard system. Manual or automatic control of the dynamometer and motor fields is applied to enable a supply suitable to supplement the existing supply to the factory to be obtained. Over 80 per cent. of the engine output is stated to be converted by the equipment into useful energy.

HENRY J. KAISER TO GET ANOTHER LOAN.—The Reconstruction Finance Corporation of America recently approved a new loan of more than 21 million dollars for use in the development of Henry J. Kaiser's steel plant at Fontana, Calif. This loan will bring the total amount approved for the plant to more than 105 million dollars. The exact use to which the new loan will be put has not been disclosed.

PROGRESS AT TACOMA.—The 40,000-kW addition to the LaGrande power-house of the Tacoma, Wash., municipal power system is expected to be in full commercial operation by November of this year. It will be the first unit of the 18-million-dollar second Nisqually power development. The final portion of the project, involving a new dam and power-house at Alder, is not scheduled for completion until next February, but a great deal of that section is now complete.

REPLACEMENT OF LOST WHALER FACTORY SHIPS.—At a meeting of the Council of the Chamber of Shipping of the United Kingdom on July 15th, it was announced that the Whaler Section of the Chamber had collaborated with the Norwegian Shipping and Trade Mission in the setting up of a British/Norwegian Joint Committee to secure the earliest possible replacement of lost floating factory ships and the resumption of whaling operations on the largest possible scale consistent with the proper maintenance of the industry.

THE FLOW OF THE THAMES.—At a recent meeting of the Thames Conservancy Board it was reported that during the five months ended June 30th the rainfall in the Thames watershed was 2·32in. below the normal fall of 10·12in. for the period. At the end of June the daily natural flow of the Thames at Teddington weir had fallen to 400 million gallons, half the normal rate. Such a condition had not occurred since 1938. The daily average flow of the river for June was 550 million gallons, compared with the standard daily average of 819 million gallons. The rainfall for the month was approximately 1·78in., as compared with the standard average of 2·23in.

AUSTRALIAN TIMBERS FOR AIRCRAFT.—A specification for Australian timbers for use as substitutes for Sitka spruce has been issued by the Standards Association of Australia as A.S. No. (E) D.811—1943. The specification provides a basis for the selection of timbers of Australian origin suitable for use in the manufacture of parts of aircraft originally designed around the properties of spruce complying with D.T.D. 36 B. The specification makes provision for classification of the timber into grades which are direct equivalents of the three grades specified in D.T.D. 36 B. Further, to assist in conserving supplies of aircraft quality timbers, the specification includes a further grade with the same compression strength as Grade A timber, but with a slightly lower Izod value. It is recommended that this Grade A2 timber be used in parts for which Grade A spruce is specified, but which are not subject to high impact loading or to stress concentrations.

Miscellanea

PLASTICS AND THE ENGINEER.—American engineers seem to be taking to plastic material more freely than on this side of the Atlantic. Pipe and tubing up to 2¼in. diameter is now available and more recently plastic nozzles, strong, durable and light, are replacing metals as an essential of fire-fighting equipment. New plastic nozzles, precision-moulded, are claimed to be corrosion-proof, non-denting, highly resistant to acid and alkalis, liquids and water content. They hold their shape perfectly and are good for practically lifelong service.

COLORADO HYDRO-ELECTRIC POWER.—The U.S. Bureau of Reclamation has announced that its thirtieth power plant has been put into war service. The plant is located at Green Mountain dam in Western Colorado, and is a part of the Colorado-Big Thompson scheme, the primary purpose of which is to provide a supplemental irrigation water supply in North-Eastern Colorado. Power from the new plant will serve areas where there are expanding war industries. When the plant's first generator began commercial production, more than 10,000 kW of new power was made available. A second unit, of equal size, is scheduled to come into operation soon, making the plant of sufficient capacity to supply a city of 50,000 inhabitants. Ultimately, six other power plants will bring the potential annual output of the Colorado-Big Thompson scheme to about 900,000,000 kWh, equivalent to the 1941 output of all the generating capacity in the State of Colorado.

MR. J. W. NASMITH.—We learn with regret of the death, on July 16th, of Mr. John William Nasmith, of Heaton Mersey. He was born in 1860 and was educated at Owens College, Manchester, under Professor Reynolds. Mr. Nasmith was the inventor of the Nasmith comber, and for the value it proved to the cotton industry he was made an Honorary Fellow of the Textile Institute.

THE CASE FOR PIPE LINES.—Mr. Ikes, the U.S.A. Petroleum Administrator, has hinted that it is "quite within the realm of possibility" that a third big pipe line from the wells to the east may be found necessary. He made the statement in a letter opposing the trans-Florida barge canal project from the point of view of the wartime petroleum situation. He argued that pipe lines can be built in a relatively brief period of time, that they use materials and power with greater efficiency than any other carriers except ocean tankers, and that they are economical to operate.

ASBESTOS SHINGLE COATING.—Investigations recently made in the San Francisco Bay area on means of protecting wood piles from borer attacks included experiments made with an asphaltic preparation covered with a layer of asbestos shingles. The asphalt was mopped on hot, a small area at a time, and before it had cooled, the area was covered with asbestos shingles, much as in applying shingles on a roof, lapping them about two-thirds the dimension both ways and tacking them down with closely spaced 2in. copper nails having large heads. *Engineering News-Record* says that three such piles were prepared and driven in a location where the coated zone remained above ground after the piles were driven, thus affording opportunity to observe the coating under action of the hammer. Conclusions were that the light weight of the coating, and hence the lack of inertia, as well as the fact that the coating was firmly fastened to the wood, accounted for the lack of any tendency in the coating to separate from the pile.

Personal and Business

EARL DE LA WARR has been appointed Director of Home Flax Production in the Ministry of Supply.

MR. E. HALLAS has been appointed technical sales manager to the Brightside Foundry and Engineering Company, Ltd.

MR. J. S. WILLS has been appointed to the boards of the South Wales Transport Company, Ltd., and Swansea Improvements and Tramways Company.

THE MINISTER OF SUPPLY has accepted with regret the resignation, owing to ill-health, of Mr. E. W. Muirsmith, Chairman, Industrial Companies' Supervisory Board, Ministry of Supply.

SIR A. STANLEY ANGWIN has been elected President of the Institution of Electrical Engineers for 1943–44. Mr. T. G. N. Haldane and Dr. E. B. Moullin have been elected Vice-Presidents.

WE record with regret the death, at West Kirby, Cheshire, on July 17th, of Mr. Sidney Woodward, secretary and local director of Cammell Laird and Co., Ltd. He was sixty-three years of age.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Building Technicians

Thursday, July 29th.—Alliance Hall, Palmer Street, S.W.1. "Site Experiences in the U.S.A.," M. Park, and "The Application of Prefabrication to Housing," H. J. Spiwak. 6.30 p.m.

Automobile Research Committee

Wednesday, July 28th.—Inst. of Automobile Engineers Laboratory, Great West Road, Brentford. Annual meeting. 2.30 p.m.

Institute of Industrial Administration

Friday, July 30th.—Livingstone Hall, Broadway, Westminster, S.W.1. Management Brains Trust. 6.45 p.m.

Royal Aeronautical Society

To-day, July 23rd.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. "Education and Training of Aeronautical Engineers." 5.30 p.m.